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THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, James T. Case, M.D., Battle Creek, Mich.

VOL. IV (NEW SERIES) FEBRUARY, 1917 No. 2

THE BUCKY DIAPHRAGM ADAPTED TO FLUOROSCOPY*

BY HOLLIS E. POTTER, M.D.

CHICAGO, ILL.

ALL rays which arise from without the anodal focus of a roentgen tube and gain access to the fluorescent screen are detrimental to fluoroscopy to the extent that they superilluminate the shadows being formed by the primary or anode focus rays. Their source is mainly from the body tissues themselves through which the rays are passing. Rays of high penetrability such as are particularly required for deep fluoroscopic work are the ones which set up within the body tissues the greatest number of these so-called object secondaries, rays which splash in all directions from their origin and have the same chemical effect on screen and plate as the direct focus rays but act always at cross purposes to them. Arising as they do at points much nearer the plate or screen than the primary rays, they strike the sensitive surface at much higher angles. This fact is of great import since it not only accounts for the lack of contrast commonly seen in fluoroscopy, but it also suggests the possibility of a mechanical remedy for the same.

During the year I attempted in the columns of our journal to revive interest in the method of suppressing these object secondaries described by Bucky in 1913, who used a multiple tubular diaphragm between patient and plate. I suggested a modification of his diaphragm grating which was so constructed and so made to move across the field exposed that in addition to absorbing large numbers of these extrafocal rays it left no image of the grating itself on the plate. This harsh grating shadow was the practical drawback to the general use of Bucky's diaphragm. While there was never any question as to its efficiency in ridding the plate of secondary effects, it left a gridiron shadow of the metal composing it which it was impossible to discount. By introducing the new factor of constant motion the shadows of the modified Bucky diaphragm were shown to largely neutralize themselves. The principles were formulated upon which the invisibility of such gratings depends with respect to their use in making roentgen plates.

Since that time those principles have been applied to fluoroscopic work. Holzknecht recommended last year in the English Archives the use of a single small cylinder between the patient and the screen for obtaining greater definition in a small field during the course of an abdominal fluoroscopic study. This has proved so simple

*Read at the Seventeenth Annual Meeting of the American Roentgen Ray Society, Chicago, Sept. 27-30, 1916.

and useful in excluding secondary rays as to have been adopted by many roentgenologists for studying the pyloric region after a general survey with an open screen. The main objection to its use lies in the increased distance between patient and plate which increases the distortions. If made is to suggest a method of overcoming that drawback by constructing a movable Bucky diaphragm which is so made and moved as to satisfy the principles laid down for invisibility in roentgenographic work plus the single new factor of speed which arises in fluoroscopy.

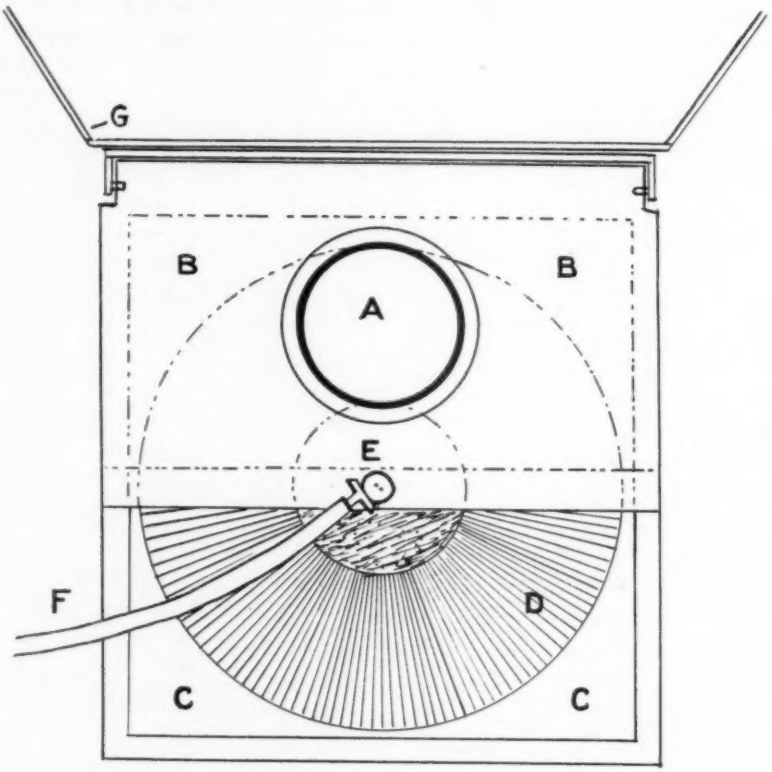


FIG. 1.

A, Fluoroscopic screen behind central ray.
B–B, Leaded screen back of disk.
C–C, Thin wooden face next to patient.
D, Disk or wheel of grating for absorption of "secondaries."
E, Mitre gearing and
F, Flexible shaft conducting power from nearby motor.
G, Fluoroscopic screen holder of upright roentgenoscope.

of many tubules of smaller diameter and much less length, as in a Bucky grating, a similar clean-up is obtained over as large an area as desired and with much less distortion, but there is again the old drawback of having to look at the metal shadows of the grating while looking through its tubular spaces. The object of this paper

Since the amount of clean-up effect can be observed as well with a stationary piece of Bucky grating as with one in motion, the fluoroscopic virtues of many sizes and shapes of grating were studied on various subjects in the course of routine fluoroscopic examination. It was soon decided that its greatest field of usefulness was

that of Holzknecht's single tube diaphragm for the visualization of calculi and the intimate study of a bismuth-filled viscus. It was therefore decided to limit our experiments to the suppression of secondaries over a small field which would allow of working at the ordinary tube-screen distance.

A multiple tubular grating was constructed in the form of a fifteen-inch wheel or disk, the peripheral five inches of which were composed of the filtering tubules, while the central five inches formed a plain hub. The whole wheel was intended to rotate in a closed penetrable case between the patient and the screen. The construction was such that each tubular opening was an imperfect square whose one diagonal lay along the radii of the disk. Upon rotation, therefore, the line of motion was along the other diagonals of the mesh and the requirements for roentgenographic invisibility were roughly satisfied. The main compromise was due to the fact that no tilting of the tubular faces was possible, but when using a small central observation area only, this was not required. The depth of each tubule was considerably greater than its width, thus approaching the ordinary diaphragm cylinder in miniature. When mounted in position, the wheel was arranged to use interchangeably with the ordinary fluoroscopic screen in the upright examining stand. The wheel was so mounted that the smallest pencil of light from the roentgenoscope was at the middle of its outer five inches of mesh work or two and a half inches from its periphery. Observations were made on a five-inch circular screen, centered immediately behind. The rotation of the wheel was accomplished first by hand and later by power from a nearby motor, transmitted through a flexible shaft. The arrangement was thus simple and self-contained and could be quickly slipped into the position of the ordinary screen, to be moved around just as the ordinary screen for the local study of one five-inch area after another.

RESULTS.—As to the suppression of the secondaries, this movable grating gave the same results as a fixed one, having the same dimensions of the tubules composing it. The question of speed was quite different to that met with in roentgenographic work where a slow constant motion was preferable. It was expected that the necessary rate of passage of individual segments past a point in the screen would be based merely upon the known interval for light perception by the eye in order to result in invisibility, and so it would if the *x*-light emitted from the tube were in a continuous stream instead of in a large number of individual pulses. As a matter of fact the main problem in speed of rotation is that of avoiding a synchronism with these pulses. With the transformer used, the tube was excited at the rate of 7200 pulses per minute. The disk of the Bucky grating had 48 mesh units in its periphery. When, therefore, the disk was rotated at the rate of 150 times a minute or 2½ times a second, there was perfect synchrony between the pulses in the tube and the passage in the meshwork before the screen, with the result that the shadow of the whole meshwork of the disk was perfectly visible and apparently stationary. On slight retardation it was still visible but moved slowly in a backward direction, until a rate considerably out of synchrony was reached. Acceleration had the opposite effect in that the mesh shadow moved slowly forward. A rate of disk speed twice, one-half or any multiple of the synchronous rate was seen to have the same effect, namely the mesh was visible. Rates of speed considerably away from these synchronous rates produced a degree of invisibility of the mesh shadow sufficient for all practical purposes. The slight indefinite pattern work seen at some of the intermediate rates when using a bare screen are scarcely visible when looking through the body.

In closing, I would say that it is my firm belief that the suppression of secondary rays is one of the most important problems before us. The increased use of Coolidge tubes which deliver so easily the

highly penetrable type of rays makes the problem doubly important. The diffusion of shadows caused by them is due to no fault in the exciting apparatus, no fault in the construction of the tube or in the composition of the screen as much as it is in the inherent laws for the formation of secondaries whenever high rays are projected through an abundance of soft tissues. If they are bound to be formed, their suppression must be accomplished either by the interposition of a substance having selective absorption for secondaries only or by some mechanical arrangement next to the screen or plate. The method herewith presented is certainly capable of minor theoretical criticisms. To me it seems the most practical compromise.

THE NATURE AND ORIGIN OF SECONDARY RADIATION *

BY J. S. SHEARER, PH.D.

Cornell University,
ITHACA, N. Y.

THE action of matter in scattering a beam of roentgen rays as well as the production of true characteristic secondary rays, has attracted considerable attention on account of the blurring of fluoroscopic and roentgenographic images.

The first discussion of this action was given by Prof. Roentgen in his third communication, March 10, 1897. The clearness of statement and insight shown may perhaps warrant quotation of a part of the first portion of this paper.

"If an opaque plate be placed between a discharge-apparatus which is emitting intense x-rays and fluorescent screen, in such a position that it shades the entire screen, there may still be noticed, in spite of the plate, an illumination of the barium platino-cyanide. This illumination can be seen even when the screen lies directly on the plate; and one is inclined at first sight to consider the plate as transparent. If, however, the screen lying on the plate be covered by a thick pane of glass, the fluorescent light becomes much weaker; and it vanishes entirely if, instead of using a glass plate, the screen is surrounded by a cylinder of sheet-lead 0.1 centimeter thick, which is closed at one end by the non-transparent plate, and at the other by the head of the observer.

"The phenomenon now described may be due either to diffraction of rays of very great wave-length, or to the fact that the bodies which surround the discharge-apparatus and through which rays pass, especially the air, themselves emit x-rays.

"Since now, as I have found, the mere contact with air which has been exposed shortly before to x-rays does not produce any sensible fluorescence of the barium platino-cyanide, we must conclude, from the experiment described, that air *during* its exposure to radiation emits x-rays in all directions.

"If our eyes were as sensitive to x-rays as they are to light-rays, a discharge-apparatus in operation would appear to us like a light burning in a room moderately filled with tobacco smoke; perhaps the colors of the direct rays and of those coming from the particles of air might be different.

"The question as to whether the rays emitted by a body which is receiving radiation are of the same kind as those which are incident, or, in other words, whether the cause of these rays is diffuse reflection or a process like fluorescence, I have not yet been able to decide. The fact that the rays coming from the air are photographically active can be proved easily; and this action makes itself noticeable sometimes in a way not desired by the observer. In order to guard against this action, as is often necessary in long exposures, the photographic

* Read at the Seventeenth Annual Meeting of The American Roentgen Ray Society, Chicago, Ill., Sept. 27-30, 1916.

plates must be protected by suitable lead casings.

"In order to avoid errors, it must always be remembered that the conditions are in general like those which would exist if we had to compare, by means of fluorescent action, two intermittent sources of light of different colors, which are surrounded by an absorbing envelope placed in a *turbid*—or *fluorescing*—medium."

The remarkable insight of the investigator is evidenced by the gradual acceptance of his original ideas. More recent investigations have shown that there exists in many cases *both* a scattering of the radiation without any change of wave length, quality or penetration *and* a *true secondary* or "fluorescent" radiation characteristic of or peculiar to the atoms of the material in which they originate. The former or scattered radiation is always present and it would be well if the term scattered radiation were used for this and the term secondary radiation were reserved for the true characteristic. The essential difference may be most readily shown by the use of the optical analogy.

If one attempts to pass a beam of light through a block of white paraffine there results an illumination not alone in the original path of the beam but also a diffuse illumination throughout a considerable volume. The block serves as a diffusing or scattering agent and the conical limitation of the beam is lost. There is, however, no change in color of this scattered radiation.

Using instead of the wax a vial filled with a solution of a suitable aniline dye we have the transmitted light changed to an amber tint by the absorption and a beautiful green light is emitted by the surface layers of the liquid in various directions. This fluorescent light is *characteristic* of the dye used and is only produced when the original or exciting beam comes from a source of sufficiently high temperature to give out wave lengths *shorter* than those of the fluorescent *beam*. In the same way the true "characteristic" roentgen radiation is only produced when the voltage at which the tube is excited is sufficiently high and this critical voltage is characteristic for each element.

It thus appears that it is not a case of deciding between two explanations, "diffuse reflection or a process like fluorescence" as Roentgen stated, but that both may be involved to various degrees. Only in the case of elements of high atomic weight is any considerable *true* characteristic produced, and then only at voltages not used in roentgenographic or fluoroscopic work. Consequently true secondary or characteristic radiation is of minor importance in roentgenography and fluoroscopy. There is but little material in the body of high atomic weight, and voltage high enough to excite their characteristic radiations is rarely if ever used. It should be noted that the scattered radiation is of the same *quality* as the original *except as modified by the filtering action of absorption.*

In order to study the photographic action of pure scattered radiation and to ascertain approximately its relative importance as compared to that transmitted along the original path, the following experiments were undertaken.

A heavy lead box open at one end was built so as to take a 5 x 7 plate. A block of pure paraffine wax about 6 x 6 x 5 inches was inserted for about an inch in the open end of the box. In some experiments a perforated lead sheet was placed between the plate and the paraffine block. In others a heavy lead plate with iron tubes three inches long was used to limit the radiation reaching the plate. The parent beam was passed parallel to the open end of the box as shown. Preliminary tests gave no darkening of the plate due to direct rays passing into the box and the scattered radiation from air was negligible as compared to that from paraffine. The amount of radiation scattered by a small volume in any particular direction depends on the nature of the material and on the amount received by that volume element. This scattered radiation is scattered again and again by

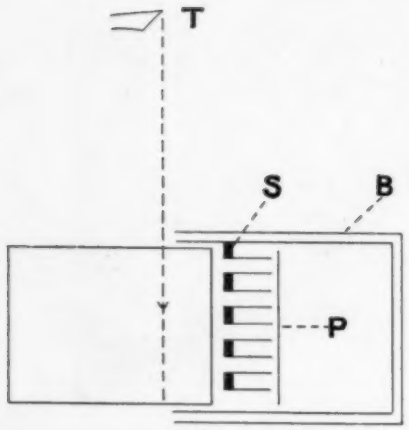


FIG.1

BLOCK OF PARAFFINE EXTENDING INTO THE OPEN END OF THE LEAD BOX.

S, A lead screen with three-inch pipes. P, Photographic plate. T, Target of *x*-ray tube.

successive portions of the material. The amount escaping from the block in any given direction is also modified by the true absorption of the material. Thus the computation of the relative intensity may be interesting but rather too complicated for practical consideration. Suffice for the present to say that the amount of scattered radiation increases in precise proportion to the direct for each element of volume. On account of absorption it results that there is more radiation available for scattering in the layers of material near the incidence of the radiation and that all lower layers are affected by the scattered radiation from all others near enough so that their scattered radiation is not mostly absorbed.

The advantage of using rays of low penetration to increase contrast is *not* to decrease scattering but so that the scattering in the upper layers will be largely absorbed. Thus, in Fig. 3, rays striking at 1 and scattered at 2 are absorbed over a path 1–2–3 before blurring an image of an object 0. Yet the cumulative effect from *all* portions of a considerable volume may cause a general haze or fog at 1. A diaphragm preventing direct radiation reaching 2 reduces scattering at that point. But rays from within the projecting cone are scattered to 2 and re-scattered to 1. Consequently a cone or diaphragm can reduce the effect of scattering but cannot entirely prevent its action. Nothing can prevent scattering if rays actually reach material.

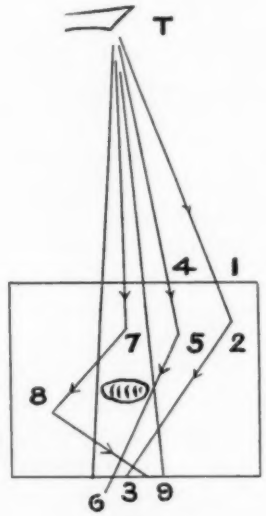


FIG. 3

PROJECTING CONE AND PATH OF SCATTERED RAYS.

1–2–3, 4–5–6 could be largely cut out by a cone, or diaphragm, 7–8–9 can not be cut off in this way.

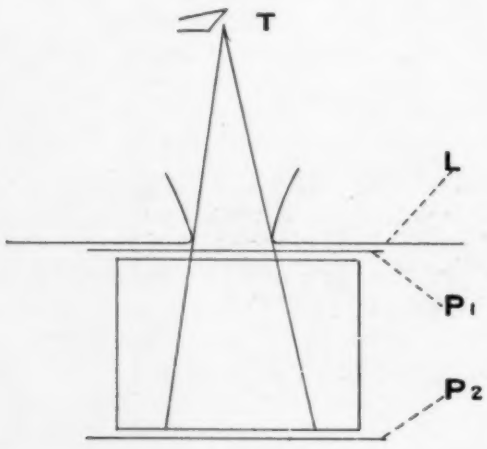


FIG 2

T, Target. L, Lead screen and treatment cone. P_1-P_2, Plates under and over paraffine block.

The action of the Bucky diaphragm and cone combined is shown in Fig. 4. No scattered radiation can reach the image from the areas ABC and DEF of the figure. The major portion of this volume does not receive any direct radiation in

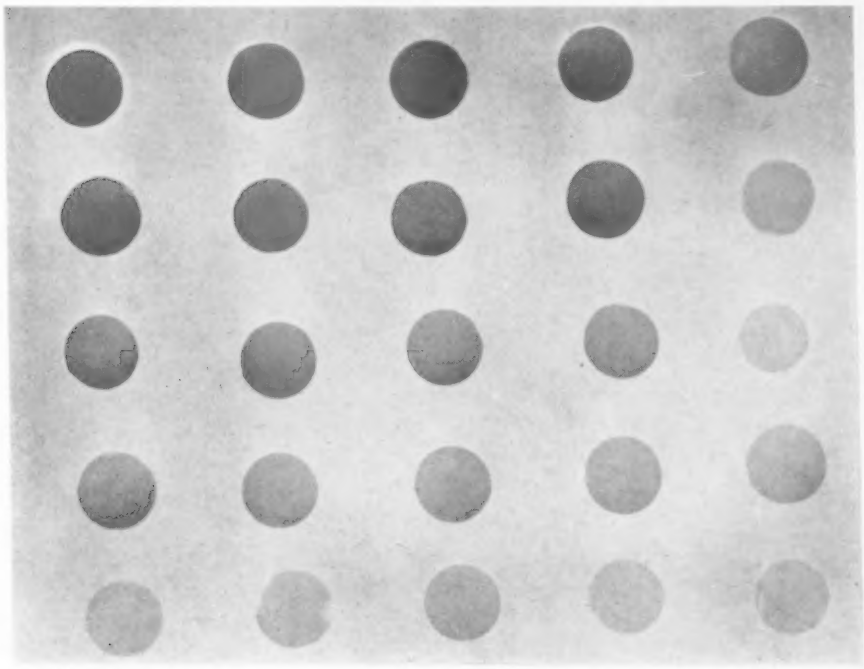


PLATE 1. MADE WITH THE APPARATUS OF FIG. 1.

Pure scattered radiation. Note greater density top and center on account of internal distribution in block of paraffine.

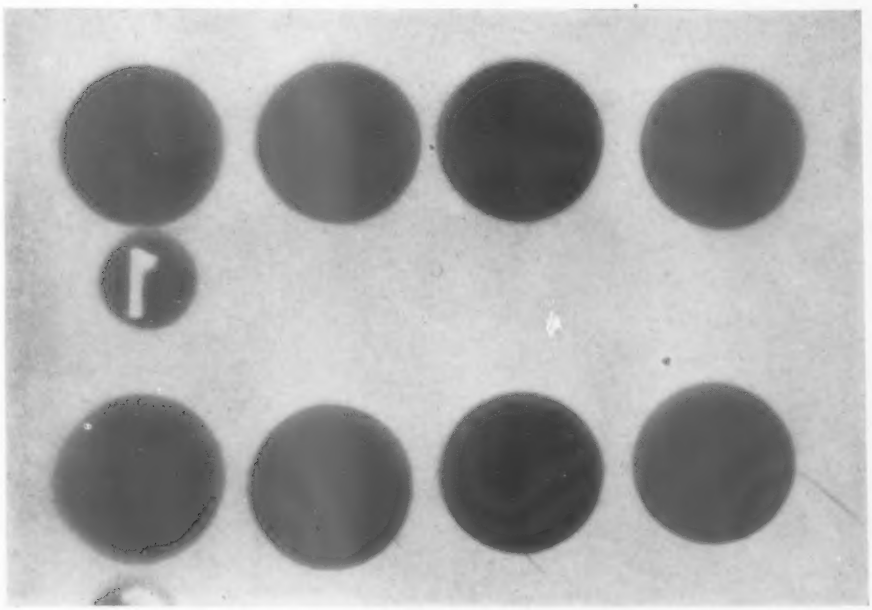
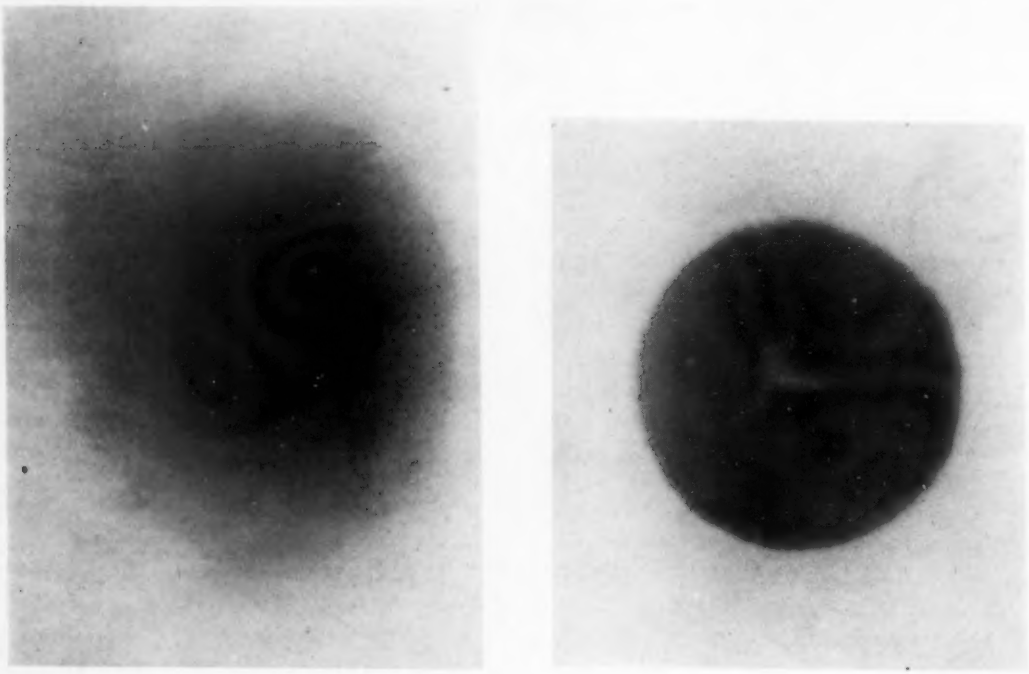


PLATE 2. MADE WITH THE APPARATUS OF FIG. 1, BUT USING A LEAD PLATE INSTEAD OF THE TUBES, SEPARATE EXPOSURES.

Various voltages from 30 K.V. up to 60 K.V. Time of exposure decreased in proportion to voltage squared. Except for lowest voltage densities are nearly equal. As the current was constant, it follows that the scattering was in constant proportion to the amount of radiation received.



PLATES 3 AND 4. MADE WITH THE APPARATUS OF FIG. 2. NO. 3 AT THE TOP OF THE BLOCK. NO. 4 AT THE BOTTOM.

About seven inches of paraffine. On account of loss by absorption there was less effect shown at the bottom than at the top. Note small cone of rays.

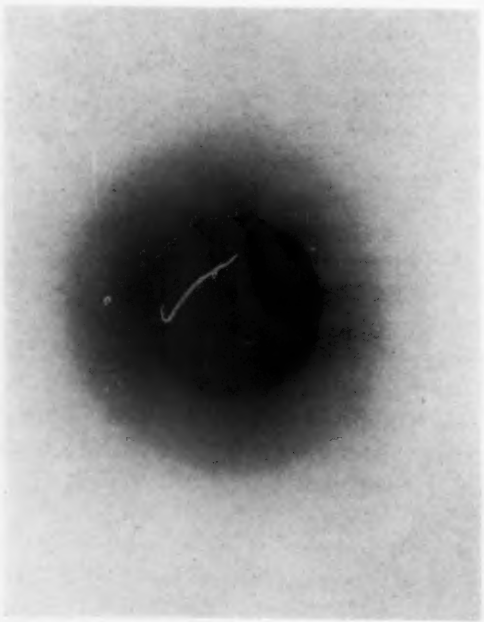


PLATE 5. SCATTERING BY 7 INCHES OF WATER.

Plate *above* the water and under lead except for the circular opening.

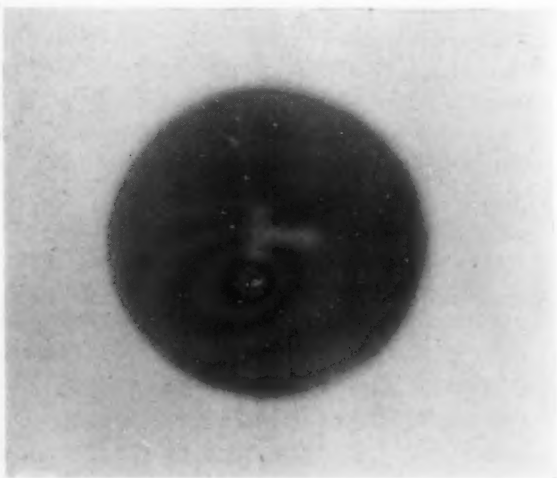


PLATE 6. TAKEN BELOW THE WATER AT THE SAME TIME AS PLATE 5.

The scattered radiation is fainter below because of water absorption. Scattered rays passing out of the water at lesser depths darken the plate outside the portion covered by water.

this case. It is clear that the two taken together will clear up the image to the greatest possible extent.

In the case of the paraffine block used, about $^1/_5$ as much radiation emerges on the average laterally as passes straight through. If in addition to this scattering action there are parasitic rays from regions in the tube other than the focal spot, the plate will be fogged or blurred by the combined action.

There is another practical point in connection with this scattered radiation that may be mentioned. In treatment it is clear that scattering distributes the radiation through a much greater volume than that included in the primary cone. Consequently any discussion of the localization of radiant action by cross fire, etc., on the idea of little or no scattering is quite beside the point. Further, if under-dosage of malignant cells results in their stimulation we may easily under-dose groups of such cells outside the directed cone of primary rays and thus accelerate the growth of new foci of malignancy.

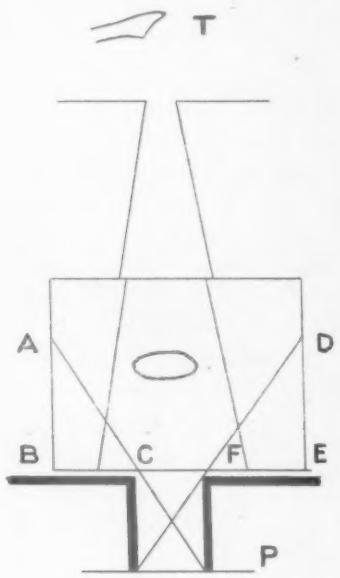


FIG. 4

BUCKY DIAPHRAGM AND CONE OR DIAPHRAGM.

The Bucky diaphragm removes scattered rays from A B C and D E F. Its effect is in a large measure due to cutting out rays from the two *small* triangles receiving *direct* rays.

An important question arises as to the danger from such scattered radiation. It may be doubted whether sufficient care has been taken in this connection. Take for example, horizontal fluoroscopy where many operators work without lateral protection. The radiation scattered toward the operator is often a considerable fraction of that passing through the body. We use lead glass to protect from the latter. Suppose that only $^1/_{10}$ as much is received by the operator as reaches the patient and that, say, sixty or more patients are handled in a week, are we quite sure that the operator is safe? This probably is much more important than protection from the true secondary from lead of which we sometimes hear. It does not seem probable that the scattered radiation from air is of any importance so far as danger to the operator is concerned, the amount being too small.

There is a third class of radiation resulting from the action of roentgen rays on matter consisting of low speed electrons torn from atoms and which are true beta rays. The slow moving positive residual rays, when a beta ray leaves an atom, have often been erroneously called alpha rays. This type of radiation is doubtless important in the therapeutic effect but hardly concerns the other phases of roentgenologic work, as their influence is limited to a *very* narrow space about their origin.

Whether the true secondary or characteristic radiation is important as a possible therapeutic agent has not been determined. From the viewpoint of the investigator in physics, the first question is how to produce such homogeneous or at least nearly homogeneous radiations in quantity and to properly measure them. When this is done one can attack the therapeutic problem with greater confidence.

I desire to express my thanks to Mr. L. P. Larkin for much assistance in the experimental work.

PHYSICAL INVESTIGATION WORK IN PROGRESS ON TUBES AND ACCESSORIES*

BY W. D. COOLIDGE, PH.D.

SCHENECTADY, N. Y.

THE following is a continuation of a paper[1] given last year and is, in the main, a report of unfinished work.

THE PRODUCTION AND MAINTENANCE OF VERY HIGH VACUA

The evolution of the vacuum pump has been very rapid in the last few years. An enormous stride was taken by Gaede who, in 1912, published the story of the so-called Molecular Pump.[2] Ever since it became available, this has been an extremely useful tool, but because of the high speed at which it runs the difficulty of keeping it in good condition for continuous operation has been very considerable. Furthermore, there was a limit to the degree of exhaustion which could be attained with it. For these reasons a great deal of interest was aroused by Gaede's announcement, in 1915, of his so-called Diffusion Pump.[3] With this device it was possible, theoretically at least, to remove the very last molecule from the space to be exhausted. There were, furthermore, no moving parts in the device. By the application of heat, mercury was caused to boil and the column of mercury vapor, upon rising, passed by a narrow slit in the wall of the container. This slit was in communication with the space to be exhausted, and any gas molecules coming from this space, and diffusing through the slit, were carried along by the ascending column of mercury vapor. The mercury vapor being condensed in the upper part of the device, ran back as liquid mercury. The gas carried up by the mercury vapor was removed by an ordinary air pump. The one serious limitation in the device was the speed of operation, which was considerably less than that of the "molecular" pump.

Dr. Langmuir, of our laboratory, has developed a new form of mercury-vapor pump—the so-called Condensation Pump.[4] It produces the same high vacuum as the "Diffusion Pump," operates more rapidly and is easier to construct. Its mode of operation may be seen by referring to Fig. 1 in which *A* represents a glass bulb containing mercury; *B* a glass tube leading into a larger glass tube, *C*; *D* a tube leading to the vessel to be evacuated, and *E* a water jacket.

The mercury in *A* is heated and kept boiling by a small electric stove underneath. Waste of heat is reduced by lagging *A* and *B* with asbestos. Between *D* and the vessel to be exhausted is a liquid-air trap which serves to condense any mercury vapor coming from the pump.

In operation, a vigorous blast of mercury vapor is maintained down through the open end of *B* into *C*. Gas molecules, coming through *D* from the vessel to be exhausted, diffusing into the mercury blast are carried downward by it to the lower end of *C*, from which point they are removed by an ordinary air pump. The tube *C* is cooled by the water jacket, the mercury vapor condenses on its sides and flows back to *A*.

With the help of the condensation pump, the evacuation of the space in an *x*-ray tube becomes a simple matter.

The manner in which gas is removed from the metal parts has already been described.[5]

The glass is, under certain conditions, a much more troublesome source of gas. Whenever a tube is heated to a higher temperature than it had while connected to the pump, water vapor and carbon dioxide are given up to the space from the inner surface of the glass. This situation is helped

[1] *Am. Journ. of Roentgenology*, December, 1915.
[2] W. Gaede, *Ber. d. d. phys. Ges.*, *13*, 775–787 (1912).
[3] *Ann. d. Physik*, *46*, 357–392 (1915).
[4] *Phys. Rev.*, *8*, p. 48, July (1916).
[5] *Ibid. 6*, 416–417 (1913).

* Read at the Seventeenth Annual Meeting of the American Roentgen Ray Society, Chicago, Sept. 27-30, 1916.

by heating the tube almost to the collapsing point while it is connected to the pump. That this does not completely take care of the problem, however, is shown by the experience we have had in attempting to greatly reduce the size of tubes.

With a 9.5 cm (3¾ inch) bulb we have found that it takes an energy input of

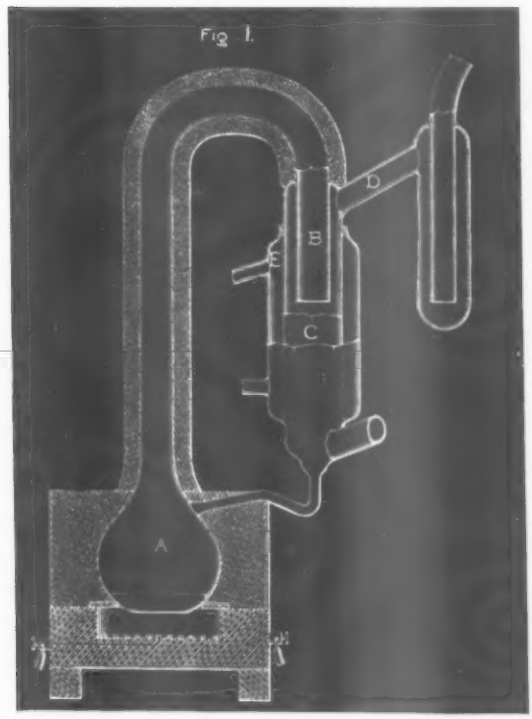


Fig. 1. Drawing of Langmuir's New Form of Mercury-vapor Pump—the So-called Condensation Pump.

1200 watts, continuously applied, to cause the glass to collapse. (The tube in this experiment had a regular solid tungsten target. The tube was freely exposed to the air, and was in a metal box 112 cm high, 56 cm wide and 114 cm long. There was no forced circulation of air.) When this tube was exhausted in the same manner as the 17.8 cm (7 inch) tube now on the market, we found that an energy input of 360 watts, when continuously applied for 1½ to 2 minutes, would cause the evolution of sufficient gas from the glass to render the tube useless until re-exhausted. After re-exhaustion, upon again testing the tube, it was found that the 360 watts, continuously applied for a couple of minutes, would once more render re-exhaustion necessary. (For ordinary roentgenographic work, the tube was all right, as this did not heat the glass to too high a temperature.)

Greatly extending the exhaust time on the pump did not help materially, and the long continued operation of the tube, with continuous evolution of gas, resulted in a very considerable metallic deposit on the bulb.

In the water-cooled tube, we had found that the use in the electrode construction of some metal which undergoes strong cathodic disintegration, such as copper for example, was very helpful. When the vacuum became sufficiently impaired, the copper was subjected to positive ion bombardment and was thereby spattered on to the glass walls of the tube. By this process, gas molecules were removed chemically and mechanically from the space and the vacuum was in this manner automatically improved by the electrical operation of the tube. The experiment was therefore tried with the 9.5 cm-tube, of introducing copper into the cathode structure (as a major portion of the focusing device). This did not appear to help the situation at all. The reason is probably to be found in the fact that in the air-cooled tube the bulb gets very hot, while it does not in the water-cooled tube. Much of the gas which is trapped by the copper deposited on the bulb is doubtless released again, if the bulb is allowed to get hot.

Thinking that we might possibly get help from it, we introduced some metallic thorium powder into the bulb of one of the small tubes. The experiment was successful and we find that the bulb of such a tube can be heated to the collapsing point without troublesome impairment of the vacuum. Metallic zirconium powder can also be used. Several other metals were tried, such as calcium, titanium and tantalum, but none of these proved helpful. (Calcium apparently has too high a vapor pressure.) It seems most probable that the rare earth metals, thorium and zirco-

nium, help in maintaining a vacuum by reacting with the gases given off from the glass, and that the solid compounds so formed have an exceedingly low decomposition pressure, even at the temperature at which lime glass softens.

We see, then, in the use of these metals one way of increasing the allowable energy input of a tube of a given size.

Another method which suggested itself was to make the tube entirely of fused quartz. This has been tried and found successful. Such a tube, only 6 centimeters in diameter, has been successfully operated continuously with 2000 watts and this without the help of forced air circulation.

At the moment, another method which does not involve the use of the rare earth metals or of fused quartz is being tried out. It consists in first heating the tube almost to the collapsing point, while connected to the pump, and then letting in specially purified nitrogen gas so as to have the same pressure within and without. The temperature is then raised to just short of the point at which the glass will sag under its own weight. This is nearly 200° C, higher than the bulb will stand when evacuated. By the alternate application of the high temperature treatment, with and without vacuum, several times, we find that the inner surface of the glass is greatly improved. By this method we have already succeeded in producing a glass tube with a 9.5 cm-bulb which can be continuously operated with as much as 600 watts, and this without forced air circulation. More experimental work is to be done on this method to see if it cannot be so modified as to enable us to safely let the tube get still hotter. (This tube in which we are now able to use 600 watts continuously without forced air circulation will not collapse with less than 1200 watts.)

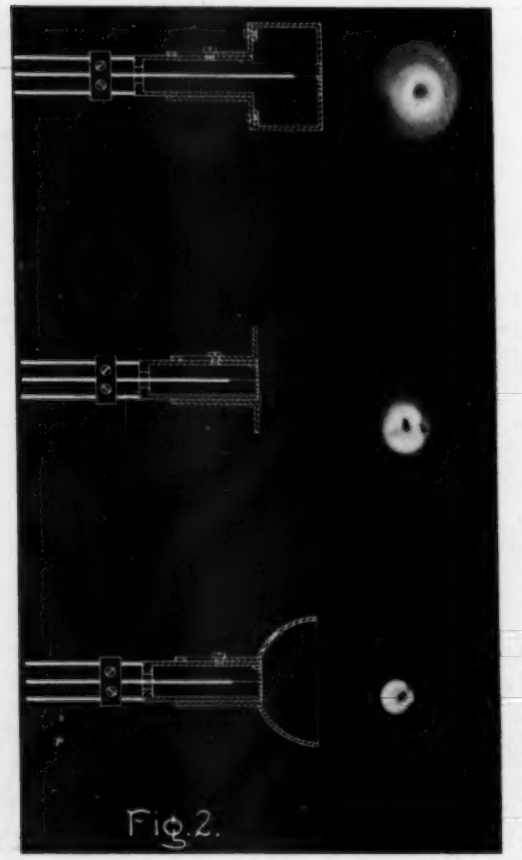


Fig. 2.

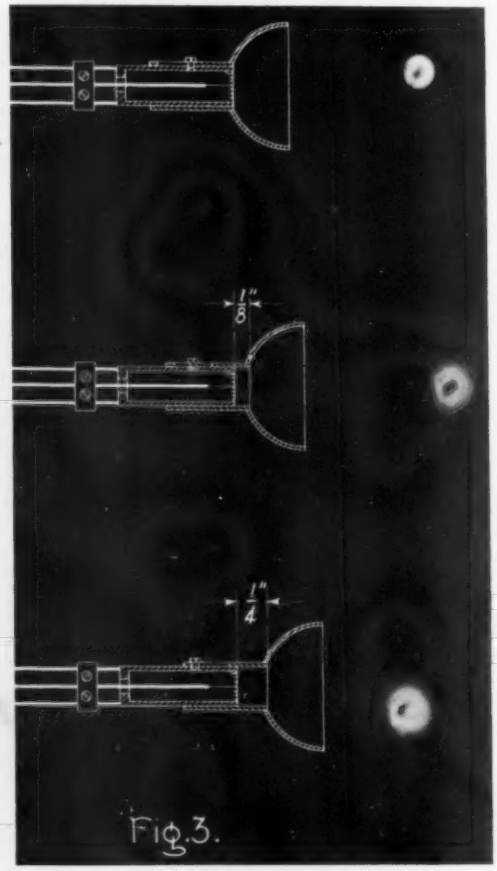


Fig. 3.

CATHODE DESIGN

To get the greatest possible *x*-ray intensity from a focal spot of given size (and this must always be the desideratum in diagnostic work), the energy delivered to the focal spot must be as uniformly distributed over it as possible. The size of the focal spot and the energy distribution are determined by the cathode design, the size and shape of anode, the distance between anode and cathode, and the size of bulb.

Widely different focal spots can be produced with the same design of filament spiral, the same design of anode, the same size of bulb and the same distance between filament spiral and anode, by merely changing the design of the focusing device. This may be seen by referring to Fig. 2, which shows three different cathode assemblies. The filament spirals are exactly alike in all three, but the focusing devices are radically different. To the right of each cathode diagram is a roentgen ray pinhole camera picture of the focal spot, made with that cathode. The anode used was in all cases the standard 45° angle type and the distance from anode to filament spiral was in all cases the same.

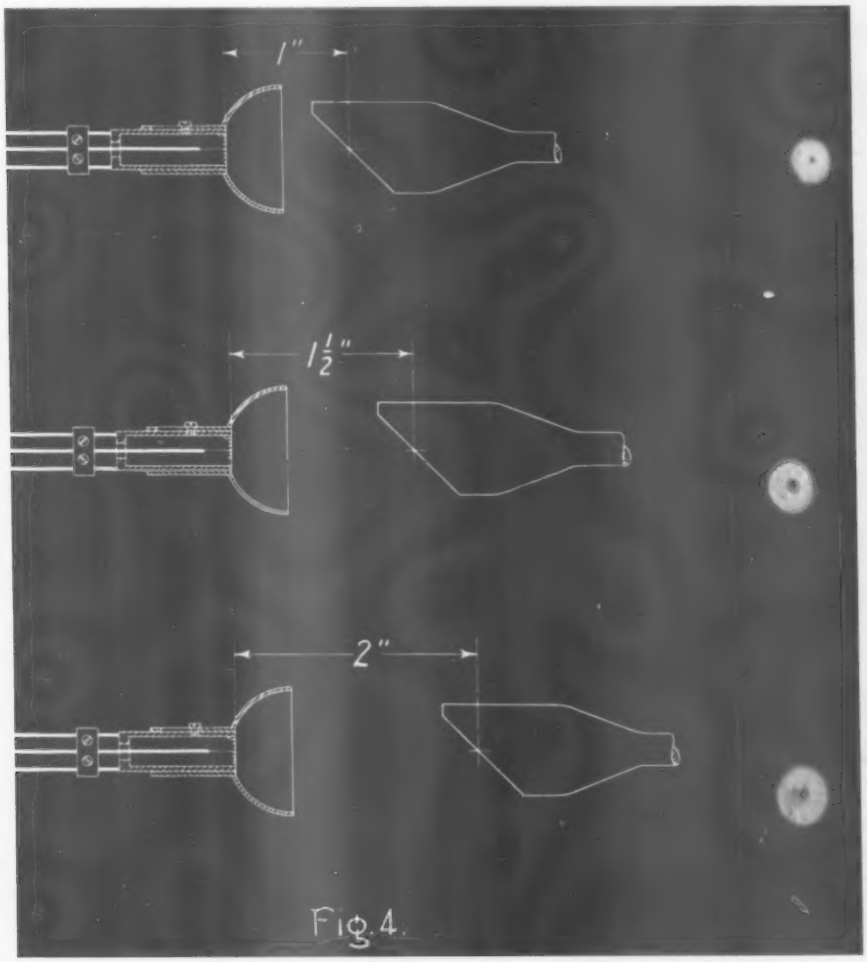


Fig. 4.

Fig. 3 shows how the focal spot changes when, all other factors remaining the same, the location of the focusing device with respect to the filament spiral is changed. The diagram shows three different settings of an adjustable cathode (these settings were made by merely tapping the tube

while it was held in an inclined position) and, to the right of each, a pinhole camera picture of the focal spot, made with that setting.

Finally, Fig. 4 shows how the focal spot changes with the distance between filament spiral and anode. In this case, the setting of the adjustable cathode was held constant and the position of the movable anode was changed.

The problem of getting the best focal spot of a given size for a given size of bulb has finally resolved itself into making up an experimental tube in which the distance between anode and filament spiral can be varied at will and in which the location of the filament with respect to the focusing device can also be varied at will. The construction of such a tube is shown in Fig. 5.

The focusing device, *d*, which is in this

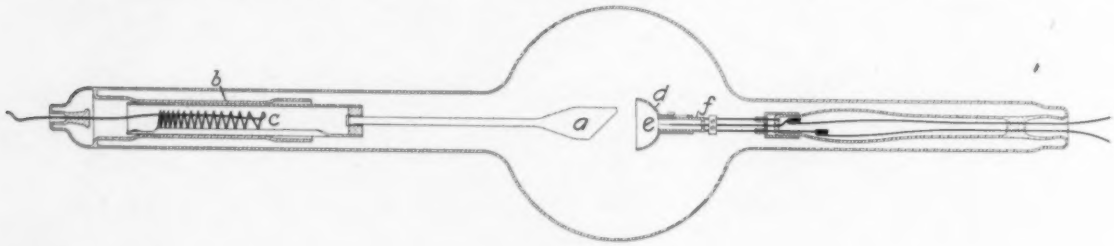


Fig. 5.

case a hemispherical bowl, is attached to a sleeve which, by tapping, can be made to slide on *f*, the molybdenum tube in which the filament spiral is fastened.

The anode also can be moved by holding the tube in a vertical position and rapping the lower end smartly against a firmly supported piece of soft wood. This causes the iron support-tube to slide in the glass tube, *b*.

Focal spot pictures are made as each variable is changed separately, and an inspection of these shows which setting of focusing device and which distance from filament spiral to anode gives the best focal spot.

METAL TUBE

In February of last year, Prof. Zehnder[6] published an article entitled "Eine gefahrlose metallische Röntgenröhre" (A Safe Metallic Roentgen Ray Tube). A somewhat similar metal tube has also been used, while connected to the pump, by Siegbahn.[7]

There seem to be many reasons why such a tube as that described by Zehnder may be impracticable, but he has, at least, stated a good problem. There are some very great advantages which might be derived from a metal tube, if it can be so constructed that it can be successfully operated.

Until we had developed a tube with a water-cooled anode,[8] we had doubts as to whether it would ever be possible to secure and maintain in a metal tube a vacuum sufficiently high for a tube with a pure electron discharge. Our experience with the water-cooled tube, however, encouraged us to try the metal tube. The first attempts were not at all promising, as we seemed to have, in the large amount of metal, a never-failing source of gas, too much for satisfactory operation even while the tube was connected to the pump. Thinking that the difficulty might possibly be due to oxidation of the metal, we filled the tube with purified hydrogen and heated it. The hydrogen, containing water-vapor from the reaction which had taken place, was then pumped out and fresh hydrogen admitted. This cycle of operations was repeated several times. After such treatment, it was found that the tube could be satisfactorily exhausted and that it would maintain its vacuum upon being sealed off from the pump.

Another very serious difficulty which we

[6] L. Zehnder, *Electrotech. Ztschr.*, Heft 5, pp. 49–50, Feb. 4 (1915).

[7] For a description of this tube, see the Inaugural Dissertation of Ivar Malmer entitled "Untersuchungen über die Hochfrequenzspectra der Elemente," Lund (1915).

[8] This Journal for December, 1915, pp. 7–10.

experienced was the puncturing and tearing of the glass, even at low operating voltages, in the neighborhood of where the glass, used to insulate the cathode, is sealed on to the metal portion of the tube. This difficulty was finally obviated by the use of an inner metal sleeve which is attached to the metal body of the tube and extends for some distance beyond the glass seal. The helpful action of this sleeve is probably due to the fact that it electrostatically prevents electrons from getting to the inner surface of the glass near the seal.

Fig. 6 shows a cut of such a tube. In the figure, *a*, the body of the tube, is of copper. The cathode, *f*, projects into *a* and is supported and insulated from it by the glass tube *c*. *b* is a flaring piece of thin-walled platinum tubing which is silver-soldered at the small end to the copper tube and sealed at the large end to *c*. The hot

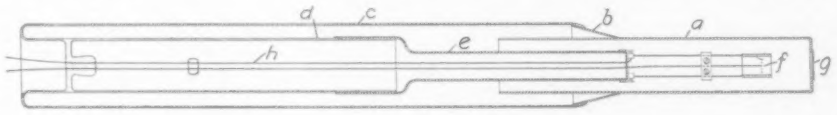


Fig. 6.

Diagram One-Third Natural Size of New Tube with Inner Metal Sleeve. (See text)

cathode, *f*, is supported by means of the copper tube *e*, which at the outer end is enlarged and fitted tightly on to the glass tube *d*. Of the two copper wires carrying current in to the filament, the one marked *h* is metallically connected to *e*, while the other is insulated. *g* is a window of thin platinum which also serves as target. It is so thin that a considerable fraction of the roentgen rays produced on the side next to the cathode pass through it and are available for use on the other side.

In operation, the metal body of the tube is connected to the positive terminal of the generator.

In most of the experimental work which has been done on the tube up to this time, there has been no window put in for the exit of the *x*-rays. In the absence of a window, and with a current of 200 milliamperes and a 4-inch spark gap, there was no visible illumination of an "Astral" screen held close to the tube.

Rays may be taken out of such a tube in two ways, either through a target of thin foil in the end of the tube or from a massive 45° angle target and out through a window in the side. The tube has been cooled by means of a metal jacket, slipped over *a*, through which water was kept flowing.

If it can be brought to a satisfactory state of development, such a tube would have, among others, the following advantages:

(1) It can be so designed that no direct rays, other than the narrow pencil desired, can leave it. The walls would either be made so thick that no appreciable amount of radiation could get through them, or a protecting jacket of lead or some other metal of high atomic weight would be slipped on the outside. This means that the present combination of a seven-inch tube and protective holder, weighing perhaps 25 or 30 lbs., could be replaced by a metal tube of higher power and more complete protection, weighing perhaps not more than half a pound. This would make it possible to simplify fluoroscopic apparatus. The small size of the metal tube would also be a convenience in therapeutic work.

(2) The tube can be built with a diaphragm, in the form of a metal cone, projecting in almost to the focal spot, so as to effectively keep within the tube all rays except those emanating from the focal spot.

(3) It lends itself to very effective cooling of the anode and, hence, to high power work.

(4) The type in which the rays are taken through a thin metal foil acting as a target in the end of the tube should be capable of development for insertion into body cavities for internal therapy. The source of *x*-rays would be in the extreme end of the

tube and the portion inserted would be all metal and connected to earth. There would therefore be no danger to the patient from either breaking glass or electric shock.

HIGH-POWER HIGH-VOLTAGE OUTFIT FOR EXPERIMENTAL THERAPY

A special transformer has been developed for use with a water-cooled tube. In this outfit the tube rectifies its own current and there is no mechanical rectifying switch. The transformer is designed to supply continuously (by the hour if necessary) a maximum current of 60 milliamperes at a maximum voltage of 150,000 (effective).

The installation of such an outfit brings new problems with it. The most vital of these is the protection of both operator and patient from both *x*-rays and electric shock. Mr. Perkins has worked out all of the details of the installation and will give a full description of the outfit in the near future in the *General Electric Review*.

With this outfit it should be possible to test out the effect of higher voltage than is now being used, and, at the same time, to resort to much heavier filtering than is now practicable.

DISCUSSION ON PAPERS OF DRS. POTTER, THRELKELD-EDWARDS, SHEARER AND COOLIDGE

DR. GEO. C. JOHNSTON, PITTSBURGH, PA.—The work done by Dr. Potter on the Bucky diaphragm is the first thing I have seen that makes me feel that the diaphragm may possibly find a place in my laboratory. Its application for fluoroscopic work might actually have some use.

I was glad to hear Dr. Shearer tell us that we will always have with us the trouble from secondary radiation. That remark was very comforting to me, because I have never been able to get rid of it.

The wonderful work by Dr. Coolidge and his associates is again placed before us. Each year there is something new and wonderful coming from the research department of the General Electric Company. The mercury vapor pump, a thing so beautiful and yet so simple, fills me with admiration. Besides it is the most artistic thing I ever saw. It is a physical romance.

Dr. Coolidge's experimental work in regard to the ordinary forms of tubes does not interest me, because the ordinary type of Coolidge tube is good enough. I wish he would develop the metallic tube, because I believe it would be of great value. Every once in a while in our therapeutic work, we run across a case of malignancy in the cavity of the body that is inaccessible to ordinary radiation. You cannot get the quantity and quality of radiation that you desire with the ordinary tube. It is my hope that soon we will have a tube coming to us from Dr. Coolidge which will be ideal for that work. The ordinary Coolidge tubes are splendid. I have five or six working all the time. The Coolidge tube will do anything you ask it to, if you know how to ask it.

MR. H. C. SNOOK, PHILADELPHIA.—Dr. Coolidge is doing all the developmental work he must do in order to make practicable the metallic tube. I think I see quite clearly that the work he is doing in connection with his glass tubes is fundamental work on which he will build in the development of any metal tube which he might later bring out and on which he might concentrate his endeavors. I agree with Dr. Coolidge that the metallic tube involves and brings along with it many difficulties, when one would attempt to make a satisfactory gas tube, such as Zander and others have worked on. Cox, of London, years ago, thought that the hot cathode type of tube offered the greatest inducement and

the least resistance for the development of a pure metal tube.

I would like to ask Dr. Coolidge whether or not in his vapor type of pump, he and his associates have found whether the shape of the ray has any great influence on its efficiency. Also I would like to know whether the temperature of the condenser he uses in his high vacuum line must be exceedingly low, or whether a temperature corresponding to that of carbon dioxid snow is sufficient for the purpose.

I am sorry that I did not hear Dr. Potter's paper. We made a very interesting observation of a phenomenon which links together the subject matter of the papers of Drs. Shearer and Potter. In using the rotating Bucky diaphragm for roentgenographic work, I have found that if the photographic plate is enclosed in an ordinary black and orange envelope, the image of the bony structure, under certain conditions of intensity and penetration, is darker than the image of the flesh, when the Bucky diaphragm is being rotated. If, however, the plate be not enclosed in a black and orange envelope, but simply placed beneath the rotating Bucky diaphragm, then the image of the bony structure is lighter than the image of the softer structures. This links Dr. Potter's subject matter with that of secondary radiation mentioned by Dr. Shearer.

I wish to express my admiration for the continued hard work which Dr. Coolidge is doing on the problems that confront us. We all admire his work and are always glad to hear about it.

Dr. L. G. Cole, New York City.—Ten years ago I read a paper before this society on direct and indirect and secondary *x*-rays. I was surprised how closely some of the expressions in my original article corresponded with the expressions used by Dr. Shearer. I have been working on this problem ever since.

Dr. A. L. Gray, Richmond, Va.—After hearing what Dr. Shearer said about the danger of secondary rays, I observe that he did not say what size diaphragm he used in the exposure of the block of paraffine. If he exposes the entire block at one time, he will get more secondary radiation than if he exposes only a small portion of it. In doing horizontal fluoroscopy, the impression left was that at all times we were obtaining secondary radiation from all parts of the patient's body. As a matter of fact, we usually expose only a small area, and consequently the secondary rays generated by the tissues well within the body have to penetrate those tissues intervening between the part irradiated and the surface and then pass a considerable distance before they reach the operator. That, I think, accounts for the fact that many of us have not received dangerous roentgen ray effects from horizontal fluoroscopy.

Mr. H. W. Dachtler, Toledo, O.—Dr. Shearer pointed out the danger to the operator and his assistants from the secondary rays. In doing my horizontal fluoroscopic work, I have counterweighted my screen and put on its sides a piece of protective leaded rubber which with a patient of ordinary thickness will just about go down to the edge of the table. This gives adequate protection for the assistant who will probably not wear apron and gloves. He can manipulate the plate-holders and screen and still not be subjected to any great amount of secondary radiation. This seems to be of such practicable importance that I am surprised it has not been used more.

Dr. Geo. E. Pfahler, Philadelphia.—I am sure that we must all express our thanks to these men for the wonderful work they have done. It will keep us thinking for years to come. The work is so far beyond us that we are not in a position to discuss it very much.

With regard to secondary radiation, I have covered my fluoroscopic table entirely with opaque rubber and then I put a false top on it. This is made of lead, so

that it will cut off some secondary radiation. I am sure that it helps.

I am very much interested in this new apparatus that Dr. Coolidge has been developing for over a year. I spent a day with him in his laboratory and I never came away from any place with more inspiration and respect for the work men are doing. This new device for the protection of the Coolidge tube will be just as much of an advance as the tube was, and whether he jumps directly from the glass to the metal tube, or whether he takes a new course, is immaterial to me, because I am convinced that whatever he does will be done right.

Dr. Kennon Dunham, Cincinnati, O. —These men deserve great credit for the work they have done and we should do all we can to encourage them in their researches. As to secondary radiation, we will always have it. Dr. Shearer's work is a warning, and we should consider it very carefully. The idea is prevalent that there is no more danger from the roentgen ray since we know how to handle it. The fact is that we do not know how to handle it. Every day we learn more about different radiations and still there is much that is unknown. While secondary radiation may not be showing its effects on the skin or body, who knows what change is taking place in the blood. Therefore, it behooves us to be very careful at all times and never forget secondary radiation and what it may do.

Dr. H. E. Potter, Chicago (in closing). I was much interested in the work presented by Dr. Shearer whose studies in secondary radiation have such direct bearing on the facts touched upon in my paper. To such authorities in physics as Dr. Shearer we in the practical field have to look for suggestions and control in our experiments. He has told us that these scattered rays will be always present in our work and has assured us that their quantity as compared with the direct rays is high. I may have been mistaken, but I received the impression that methods directed to the suppression of these rays would meet with difficulty if not failure. I hope he will assure us that he had in mind that it would be futile to attempt to suppress them at their source, that is, prevent their formation in the body.

His experiment of placing a photographic plate behind lead walled tubes so placed that scattered rays from paraffine would register the quantity of scattered rays only on the plate is very interesting, since it shows us the quantity given off at different depths of paraffine. It does not, however, prove that a considerable number of scattered rays were not absorbed in the lead walls of the tube during passage. It would be absurd to claim that the walls of the tube would in any way obstruct the passage to the plate of scattered rays arising from particles of paraffine in direct line with the tube's lumen. But there is plenty of paraffine on every side giving off these rays and it is from all these more distant particles of paraffine that the rays are suppressed or absorbed by the walls of the tube. The very experiment given could easily be modified or amplified so as to give us the best quantitative measure of the absorption of secondaries by one or more tubes merely by leaving uncovered a good-sized space at a reasonable distance to one side. This would allow a registration on the photographic plate of secondaries from all sources which would be found to far exceed those gaining passage through the tube, and the difference would represent the clean-up effect due to the tube. As far as I can see, Bucky gratings will always allow the entrance of object-secondaries from immediately above the tubules, but in all my practical tests I have felt amply repaid for successfully screening off those arising at more distant points.

Dr. J. S. Shearer, Ithaca, N. Y. (in closing).—I want to emphasize one point in connection with Dr. Coolidge's paper. I want to warn you that in dealing with the auto-transformer, or any outfit which

gives a constant potential, irrespective of the amount of current, you are dealing with an extremely dangerous outfit. If an electrical engineer should take anything like the chances some of us take in handling high voltage, he would be subjected to most severe criticism. Public service corporations would not tolerate such risks. I should object very seriously to anyone's advising the use of an auto-transformer in treatment work, where you go up to a 9 or 10 inch spark gap. We had two experiences in our laboratory which emphatically pointed that out. An assistant was making some preparations for an experiment and let the tube get closer to the table than it should, an arc struck to the metal, set things on fire, taking out a few circuit breakers and doing considerable damage. In another instance, a curiously inclined individual opened the oil switch and immediately closed it, but dropped the rectifier back so as to reverse the current, and we had some fireworks which were most interesting. The fuse on the main line and circuit breakers are not adequate protection. You must avoid starting these arcs, and you must arrange it so that a patient in raising a leg or an arm will not come in contact with wires or even near them.

I am sorry that time would not permit of working up this secondary ray work as I would like. The experiments shown are not complete. It is exactly on the questions of where this secondary or scattered radiation arises, its amount as compared with the direct and what measure of improvement we might expect that we are working on at the present time.

I want to express my admiration of the mechanical scheme worked out by Dr. Potter in the making of this improved Bucky diaphragm. When we speak of suppressing scattered radiation, we mean suppress it at the source, i.e., prevent its production. That is an impossible proposition. On the other hand, he has been working to avoid the disastrous effects of secondary radiation by keeping it away from the region where it does the most harm. This is all we can hope to do.

Regarding what Dr. Gray said, when going down through the body a large part of the radiation is absorbed. In the paraffine, the maximum of the scattered radiation arose between about an inch and an inch and three-quarters below the surface, and it frequently happens that a good deal of this scattered radiation could get out to the operator without going through a large amount of tissue. I have often been astounded at the chances taken both in the matter of protection against high tension discharges and direct and scattered radiations. You cannot afford to do it. We should use every means to avoid danger rather than subject our work to criticism after injury.

Dr. W. D. Coolidge, Schenectady, N. Y. (in closing).—I cannot help expressing my appreciation of the work of Dr. Potter. It seems to me that his rotating diaphragm will surely come into general use for fluoroscopy.

Dr. Cole's double slot method for roentgenography also looks extremely valuable and practical to me.

In reply to Mr. Snook's question concerning the condensation pump, I may say that Dr. Langmuir is investigating the effect of changes in design, on the speed of operation, and that he is developing a pump in which the glass is replaced by thin sheet metal. He will publish his results in the very near future.

NEW DEVELOPING FORMULA FOR X-RAY PLATES

BY VIKTOR AAGAARD

Assistant in Roentgenography, Battle Creek Sanitarium

BATTLE CREEK, MICHIGAN

ON account of the war in Europe it has for some time been impossible to secure a supply of the old reliable photographic developers. There are, however, now on the American market several new developers which can be made to yield equally good results.

After some experimenting the formula given below is recommended. The plates will show plenty of detail, with proper contrast for *x*-ray work. The developer will stand exposure to the air in an open tray for twenty-four hours or more without enough discoloration to produce stain on the plates. When the developing solution is practically exhausted it will have developed a greenish color.

Distilled water should be used in making up the formula. The figures in the formula refer to avoirdupois weight and measure. The chemicals should be mixed in the order named and the developing solution maintained at a temperature of 65° F.

Formula:

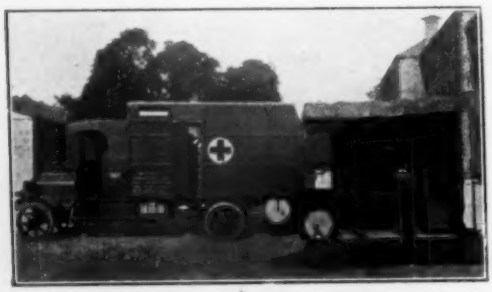
Water	60 oz.
Fredol	70 grs.
Sodium sulphite (desiccated)	3½ oz.
Hydrochinon	300 grs.
Sod. carbonate (desiccated)	3 oz.
Potassium bromide	35 grs.

When the fredol is mixed with the water it will show a strong purple color, which changes to a light brown on the addition of the sodium sulphite.

It will require about ten minutes to develop a properly exposed roentgenogram.

A MOTOR X-RAY OUTFIT

THE *Lancet* (London) gives an illustration of one of the five *x*-ray motor-wagons presented by the Scottish branch of the British Red Cross Society for service in the field. The chassis is of the 32-horse power Albion three-ton type, and the body has been constructed to meet the special requirements. The door half open in the center of the body shows the accumulators, which are supplied with current from a dynamo mounted on the chassis under the driver's seat; the dynamo is driven by means of a clutch arrangement from the carden shaft of the vehicle. The *x*-ray tube is fixed to a carriage on rails for operating purposes. The negative-holder is above the table, as well as a small screen for protecting the legs of the operator traveling on a single rail to follow the *x*-ray tube. The two cable-drums, one attached underneath the rear portion of the body, and the other seen lying on the ground, are to enable the *x*-ray operating table to be taken some distance away from the vehicle should circumstances make this necessary. The canopy shown extended at the back of the wagon is collapsible and the whole apparatus can be stored inside the vehicle for transporting from place to place.



X-RAY AUTOMOBILE OF THE BRITISH RED CROSS

THE PATHOLOGIC REASONS FOR THE LEGITIMATE ERROR IN X-RAY DIAGNOSIS OF GASTRIC CARCINOMA AND ULCER*

BY WILLIAM CARPENTER MAC CARTY, M.D.

Mayo Clinic

ROCHESTER, MINN.

AN analysis of the pathologic conditions in the stomach in relation to the physical basis of roentgenology necessitates a consideration of two things, i.e., the physical facts which make the roentgen rays capable of utilization and the anatomico-pathologic facts relative to gastric lesions.

As utilized in the diagnosis of gastric carcinoma and gastric ulcer roentgenology depends upon structural abnormality, abnormality of gastric rhythm, tissue density and the behavior of artificially administered dense gastric contents.

From a standpoint of the pathology of these two conditions experience with 862 specimens, which have been removed by excision or resection at operation, distinctly shows that there are no recognizable differences in structural outlines in early carcinomata and simple chronic ulcers (Figs. 1-11). The ulcerations in both conditions may be deep or shallow, large or small, and may possess overhanging, gradually receding, hypertrophic or atrophic borders (Figs. 5–8 and Diagram I). The specimens themselves in the hands of a most competent surgical pathologist cannot be positively differentiated from their outlines.

In regard to functional rhythm with which roentgenologists have had more experience than the writer, it might be said, from the anatomical basis of rhythm which lies in the contractility and continuity of the musculature, that there is nothing characteristic in either simple gastric ulcer or carcinomatous gastric ulcer. In both conditions the musculature may be intact or broken and histologically normal or abnormal.

The behavior of dense gastric contents as an aid to *x*-ray diagnosis is valuable only in that it aids in the recognition of structural abnormality and the character of gastric rhythm and therefore may be considered merely a tool to be utilized in the study of these two factors.

Tissue density from an *x*-ray standpoint is a field for investigation which has been scarcely touched in the literature. That large amounts of carcinomatous tissue may have a recognizable difference in density from purely inflammatory or normal tissue is highly conceivable, but that quantity of tissue examined plays an enormous rôle in the *x*-ray determinations of density is likewise conceivable.

To the pathologist the essential feature of the question as to the roentgenologist's ability to differentiate gastric carcinoma from simple chronic ulcer is one simply of the quantity of carcinomatous tissue which is recognizable by means of the *x*-rays. I shall, therefore, merely state the anatomico-pathologic facts which have been determined from a study of 318 chronic gastric ulcers and 602 carcinomatous chronic gastric ulcers.

1. There are advanced carcinomata associated with gastric ulceration in which there is no possibility of determining which condition was primary (Fig. 6).

2. There are simple chronic gastric ulcers in which there are no visible signs of carcinoma (Figs. 3, 4, 5, 7, 9).

3. There are simple chronic gastric ulcers in which the epithelium of the gastric tubules is intact, the cells being columnar or cuboidal and regularly arranged; the inter-

*Read at the Seventeenth Annual Meeting of the American Roentgen Ray Society, Chicago, Sept. 27, 1916.

FIG. 1. (C. A76248.) GASTRIC CARCINOMA

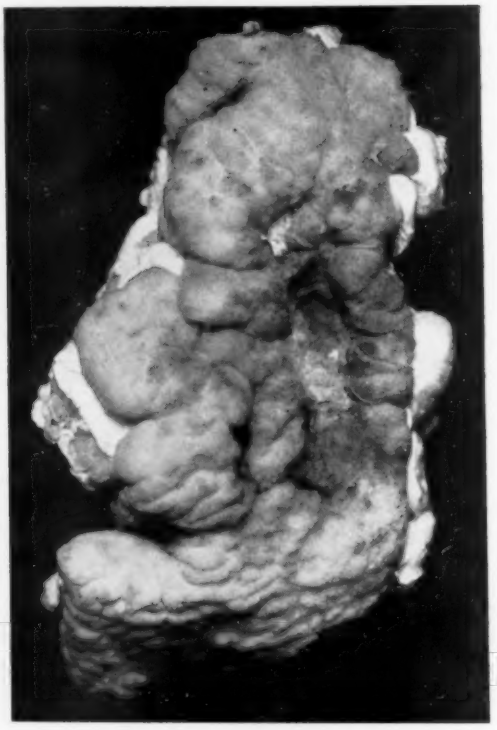


FIG. 2. (C. A68087.) GASTRIC ULCER

glandular stroma is infiltrated with lymphocytes and there is congestion and edema coincident to chronic inflammatory reaction in the mucosa (Figs. 12, 13, 14). This condition of the epithelium has been described by the writer as primary epithelial cytoplasia.

4. There are simple chronic gastric ulcers which are indistinguishable in every anatomical and histological detail from ulcers which have just been described excepting the condition of a part or all of the glandular epithelium. In this group the intra-tubular, columnar or cuboidal cells are totally or partially replaced by irregularly arranged ovoidal or spheroidal cells which have clear protoplasm, centrally placed, with less dense nuclei and prominent nucleoli. It has been repeatedly observed that these spheroidal or ovoidal cells are morphologically indistinguishable from unquestioned carcinomatous cells which are found in the stroma and metastases. This condition has been described as secondary epithelial cytoplasia (Fig. 17).

5. There are chronic gastric ulcers similar in all histologic characteristics to the ulcers just described plus the presence of the ovoidal or spheroidal cells in the interglandular stroma, the line of demarcation

FIG. 3. (H. 18088.) MULTIPLE SIMPLE ULCERS AND ONE LARGE CARCINOMATOUS ULCER

FIG. 4. (H. 28173.) SIMPLE GASTRIC ULCER

FIG. 5. (C. A43484.) SIMPLE GASTRIC ULCER

FIG. 6. (H. 21882.) DEEP GASTRIC CARCINOMA

FIG. 7. (H. 18088.) CROSS SECTION THROUGH FIG. 3

FIG. 8. (C. A76248.) CROSS SECTION THROUGH FIG. 1

FIG. 9. (H. 28173.) CROSS SECTION THROUGH FIG. 4

FIG. 10. (H. 21555.) CROSS SECTION THROUGH AN EARLY CARCINOMATOUS ULCER

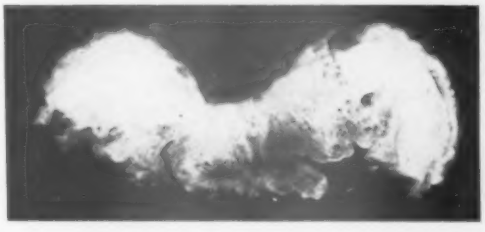


FIG. 11. (C. A68087.) CROSS SECTION THROUGH FIG. 2

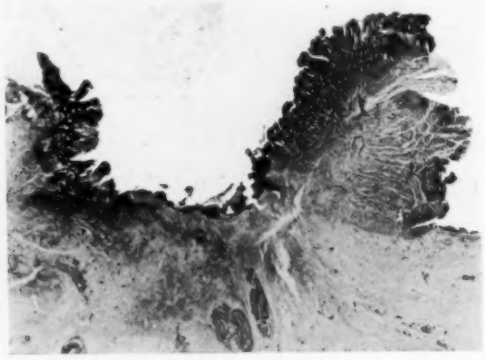


FIG. 12. (C. A86829.) SIMPLE CHRONIC ULCER

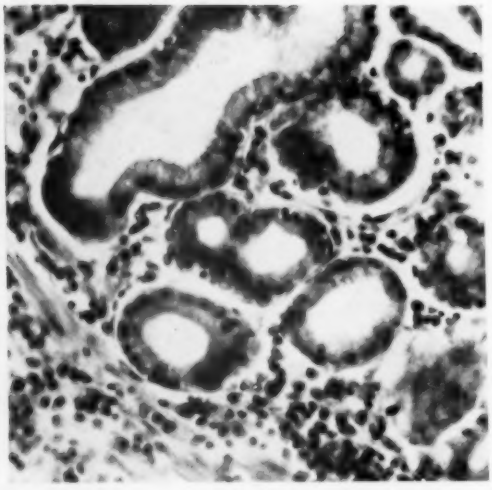


FIG. 13. (C. A73003.)

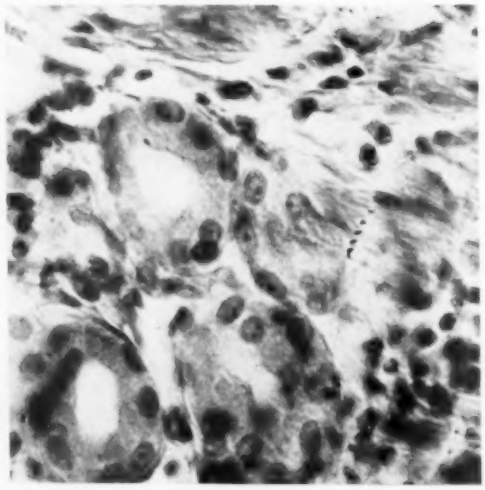


FIG. 15. (C. A84970.)

FIG. 14. (C. A75082.)

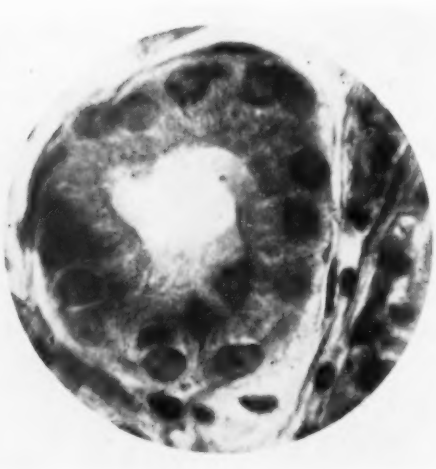


FIG. 16. (C. A75082.)

FIGS. 13–16. EPITHELIAL CONDITIONS IN SIMPLE CHRONIC GASTRIC ULCERS

between the tubules and the stroma being confused or absent, a condition described as tertiary or migratory cytoplasia (Figs. 18, 19). Primary epithelial cytoplasia is a benign cellular condition, secondary epithelial cytoplasia is a cellular precancerous condition and tertiary or migratory epithelial cytoplasia is a definitely malignant condition (Figs. 14, 17, 19 and Diagram II).

These facts in the gastric mucosa are in accord with cytologic facts regarding certain tissues in other organs which have served to form the basis of a modern bio-

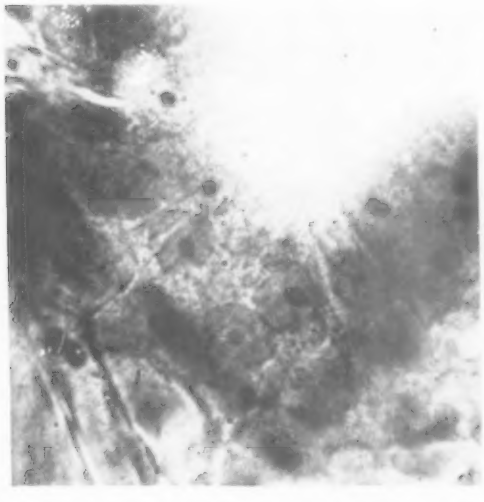


FIG. 17. (C. A55230.) SECONDARY EPITHELIAL CYTOPLASIA IN THE BORDER OF A GASTRIC ULCER

logic conception of cancer. It has been repeatedly stated by the writer that cancer is a migratory hyperplasia of the regenerative cells of a tissue, a generalization which has for its basis a biological study of cells in general and the facts observed in the attempted regeneration of tissues after destruction during which regeneration there is hypertrophy, hyperplasia and finally migration of the cells which normally regenerate the specific cells which characterize or constitute a tissue.

Without entering into a prolonged exposition of this phase of the subject it is sufficient to say that carcinoma as well as all forms of neoplasia are a question of cells, the earliest recognizable changes in which

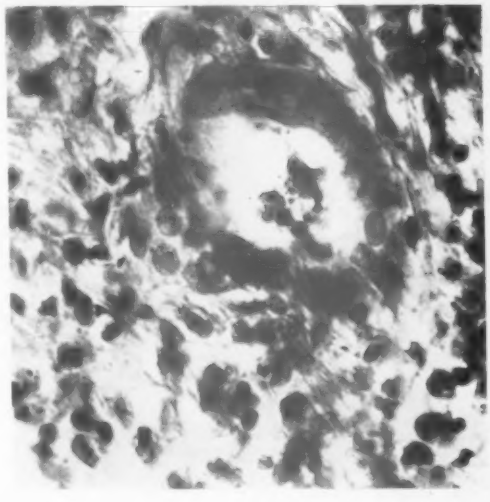


FIG. 18. (C. A84970.) TERTIARY OR MIGRATORY EPITHELIAL CYTOPLASIA IN THE BORDER OF A GASTRIC ULCER

are only visible under the highest powers of the microscope. This being a fact it is not conceivable that the roentgenologist, the clinician and the surgeon will ever be able to differentiate a simple chronic gastric ulcer from a simple chronic gastric ulcer with early carcinomatous changes, the latter condition being, as experience has taught us, the only pathologic condition in the stomach in which a malignant neoplasia can possibly be completely cured with any known therapeutic agents.

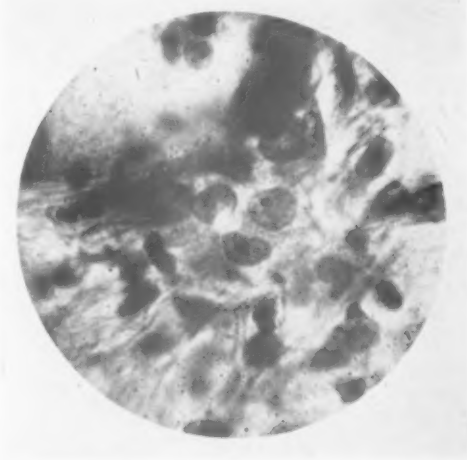


FIG. 19. (C. A84970.) TERTIARY OR MIGRATORY EPITHELIAL CYTOPLASIA IN THE BORDER OF A GASTRIC ULCER

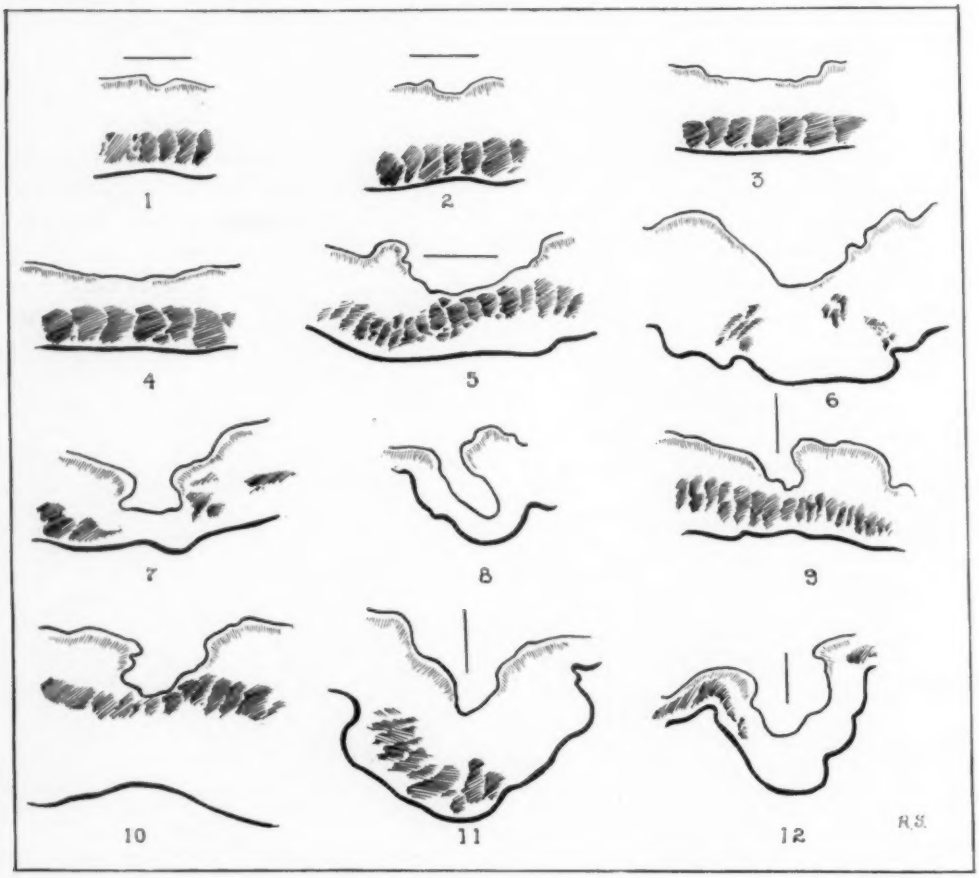


DIAGRAM I. IRREGULARITIES OF OUTLINES OF GASTRIC ULCERS AND CARCINOMAS

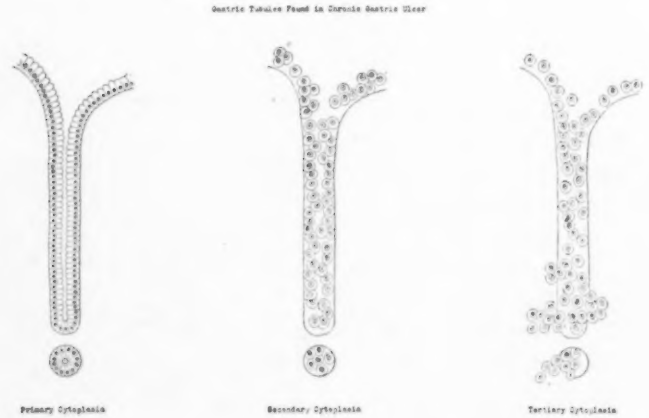


DIAGRAM II. PRIMARY, SECONDARY AND TERTIARY CYTOPLASIA IN GASTRIC TUBULES

It is certainly true that the roentgenologist, the clinician and the surgeon can recognize advanced carcinoma, but the assumption that a few distinctly carcinomatous migratory cells within the confines of the mucosa will alter the physical conditions, which are the basis of *x*-ray diagnosis, so as to prove malignancy seems inconceivable to the surgical pathologist who must search with a microscope before making the diagnosis.

One does not need further to attempt to demonstrate the impossibility of gross differential diagnosis because every honest clinician, roentgenologist or surgeon who has had any extensive experience with gastric conditions has made diagnoses of gastric carcinomata which were simple chronic ulcers and simple chronic ulcers which were carcinomata; indeed, they have even made diagnoses of these conditions without finding any demonstrable gastric lesion. It is not my duty as a pathologist to analyze, for presentation, a large itemized series of mistakes in the *x*-ray diagnosis between the conditions under discussion. This should be left for the scientific roentgenologist who by so doing might keep less experienced roentgenologists from deceiving themselves and assist them toward a higher and more scientific conception of medical efficiency.

There is another bit of individually known evidence which has evolved in the experience of those who have to do with gastric conditions from an *x*-ray standpoint; the terms "gastric, pyloric or prepyloric lesion" have come prominently to the front. This fact simply means that the roentgenologists, like other clinicians, are beginning to experience what was known centuries ago to a Chinese physician, who wrote a work on medicine in which he stated that the successful physician is the one who recognizes the possible from the impossible.

The pathologic reasons for the legitimate error in *x*-ray diagnosis of gastric ulcer and gastric carcinoma seem to be the following:

1. There is no macroscopic differentiating structural difference between a simple chronic gastric ulcer and an early carcinomatous chronic gastric ulcer.

2. There is no differentiating variation in muscular structure which might be the basis of diagnostic difference in gastric rhythm in simple chronic gastric ulcer and an early carcinomatous chronic gastric ulcer.

3. The diagnosis of early carcinoma in the border of a chronic gastric ulcer is a question of the position of a few undifferentiated epithelial cells in the mucosa or submucosa, and it still remains an open question whether or not the *x*-rays can differentiate such small quantities of such cells from normally differentiated epithelial cells or the cells of the other tissues in a chronic ulcer.

THE AUTHOR'S CONTRIBUTIONS TO GASTRIC CARCINOMA AND ULCER AND THE HISTOGENESIS OF CARCINOMA

"Pathology and Clinical Significance of Gastric Ulcer." *Surg., Gyn. and Obst.*, May, 1910.

"Involvement of Regional Lymphatic Glands in Carcinoma of the Stomach." *Annals of Surgery*, June, 1912.

"Gastric Ulcer and Its Relation to Gastric Carcinoma." *Arch. for Int. Medicine*, Feb., 1914.

"The Histogenesis of Cancer of the Stomach." *Amer. Journ. Medical Sciences*, April, 1915.

"Carcinoma of the Breast." *Old Dominion Med. Journ.* and *Transactions of Southern Surgical Association*, Dec., 1910.

"The Histogenesis of Cancer of the Breast." *Surg., Gyn. and Obst.*, Oct., 1913.

"Clinical Suggestions Based Upon a Study of Primary, Secondary (Carcinoma?) and Tertiary (Carcinoma) Epithelial Hyperplasia in the Breast." *Surg., Gyn. and Obst.*, March, 1914.

"The Histogenesis of Ovarian Carcinoma." *Collected Papers*, Mayo Clinic, 1913.

"The Biological Position of the Carcinoma-Cell." *Collected Papers*, Mayo Clinic, 1914.

"Precancerous Conditions." *Journ. of Iowa State Medical Society*, July, 1914.

"Notes on the Regularity and Similarity of Cancer Cells." *Collected Papers*, Mayo Clinic, 1914.

"New Facts About Cancer and Their Clinical Significance." *Surg., Gyn. and Obst.*, July, 1915.

"The Evolution of Cancer." In print.

"Facts versus Speculation in the Professional Conception of Cancer." *Texas State Journ. of Medicine*, July, 1915.

"A New Classification of Neoplasms."

DISCUSSION ON PAPER OF DR. MacCARTY

DR. A. L. GRAY, RICHMOND, VA.—I am delighted to have the opportunity of seeing demonstrated what appears to be a precancerous condition developing in an ulcer. It seems to me that this is very encouraging. Dr. MacCarty says he does not know what the secondary hyperplasia is unless it is a precancerous condition. It is one step further toward malignancy as I see it. In my own work, I never pretend to say whether an ulcer is beginning to be malignant or not, and no one has the right to say that it is. If we see nodular indentations or the "bitten out" appearance in the opaque meal shadow, we can say with a very high degree of certainty that the condition is malignant.

I was very much impressed with the answer of one of my colleagues to a leading surgeon in one of our best universities, when he was asked a few days ago what he thought of the roentgen ray in gastro-intestinal work. The answer of the roentgenologist was that he thought it was exceedingly reliable in skilled hands in certain cases and that the way to determine its value was to examine the reports coming from the large clinics. The surgeon was exceedingly skeptical. Why? Because he had had his work done chiefly by an intern in the hospital. When we have reports on gastro-intestinal work made by the interns in our hospitals, we can expect nothing but unsatisfactory results.

I believe that roentgenology of the gastro-intestinal tract has arrived at a definite position in the field of diagnosis, provided the examination is made by a competent man. I do not mean necessarily a man who has confined himself exclusively to gastro-intestinal work; I certainly do not mean a man who has a machine and does only a little general work: I do mean the man who has studied the subject carefully and who has arrived at his conclusions scientifically after abundant experiences and painstaking observations.

DR. GEO. C. JOHNSTON, PITTSBURGH, PA.—There is one reason why we have had the pleasure of hearing Dr. MacCarty's paper and seeing his beautiful work. There has been to my knowledge a friendly little race going on between Dr. MacCarty and Dr. Carman. Dr. Carman hopes some day to find a carcinoma which Dr. MacCarty cannot find, and Dr. MacCarty, in turn, hopes to show carcinomatous ulcers which Dr. Carman pronounced innocent. Between them very few ulcers will go undetected. Dr. MacCarty's work is appreciated by only a few. I appreciate the great beauty of the slides, and the reproductions and the diagnosis based on the cell changes in the periphery. It is impossible for the roentgenologist to determine by the gross outline or profile shadow of a hollow viscus filled with opaque fluid anything within several thousand times the size of the beginning lesion shown by Dr. MacCarty. That is not the way the roentgenologist hopes to do it. He cannot see the few wandering cells in the tubule of a gland, but he does sometimes see whether it is an ulcer which is macroscopically malignant, not microscopically. Why does it sometimes give rise to a different profile in a stomach from that caused by a simple ulcer? That has led me at times to insist strongly on a pylorectomy and on having a real pathologist examine the tissue. It provokes me to have some one soak a piece of tissue in alcohol or formalin or something else, and then have some one who *thinks* he is a pathologist examine it days later and say what he believes it to be. Dr. MacCarty's work is not done in that way. Between the time the tissue is excised and Dr. MacCarty's examination of it, only a few minutes elapse.

Under such circumstances I have been able once or twice to show that an ulcer which caused no symptoms, other than those we expected to note in a case of simple ulcer, was malignant. If these

studies are carried far enough, great good will come of them.

Take a very chronic ulcer of the pylorus, one so small that when the abdomen is opened, you wish you were not there. You feel that there is nothing wrong. The surgeon palpates the pylorus and finds that it does not feel just like a normal pylorus. He has confidence in you and decides to do a pylorectomy. The pathologist later reports it to be a carcinoma. That has occurred to me several times and the one thing that has impressed me strongly was the very small amount of actual pathology present and the very large amount of gastric disturbance. A decided spasmodic contraction of the pyloric end of the stomach was present.

I think Dr. MacCarty has the wrong idea of what we are trying to do. We are not trying to be pathologists. That is not our business. It takes all any man can do to be a roentgenologist and all a man can do to be a pathologist. He cannot be both.

Dr. W. P. MacCarty (closing).—As long as I live, I never will have any fight with the roentgenologist, the surgeon, the clinician, or any other pathologist, because I am in the game to help to produce efficiency. We all ought to work together. All I do is to make observations and draw conclusions, in a general way, based on these observations, and to give these generalizations to practical men who will use them to help to increase efficiency in medicine. Therefore, there never will be any trouble between the roentgenologist and me. But unless we work side by side, we will never progress. Dr. Carman, Dr. Moore and I always work together. If we make mistakes, as we all do, we try not to make the same mistake again. We get together and talk it over so as to prevent such happenings. The pathologists in our institution never criticize the roentgenologists.

As to the element of accident in making a diagnosis, if you place one hundred ulcers of a certain size on this table and ask me to look at them, I may tell you that a high percentage of ulcers larger than a quarter of a dollar are carcinoma. At least 75 per cent are carcinoma. That has been my experience. One day one of our assistants—and they are always looking for a chance to get you—brought me an ulcer larger than a quarter and called my attention to the claim I had made that they are always carcinoma. The specimen he had was not a carcinoma and I had to admit it. We are trying to make progress and it is just such cases that I am looking for in order to eliminate the 25 per cent of nonmalignant ulcers. I want to bring pathology to the point where we can make diagnosis and treatment more proficient and I hope that you will help me. No one can do it alone. We must work together. By coöperation we are going to accomplish much. We are living in the brightest era in the history of medicine because we are coöperating.

SYPHILIS OF THE STOMACH*

FURTHER STUDIES, BASED ON NINETEEN CASES

BY LEON THEODORE LE WALD, M.D.

Instructor in Roentgenology, New York University and Bellevue Hospital Medical College; Director Edward N. Gibbs Memorial X-Ray Laboratory, and Roentgen Department, St. Luke's Hospital,

NEW YORK

DURING the past three years, nineteen cases showing roentgen evidence of gastric lesions associated with a positive Wassermann reaction have been encountered in St. Luke's Hospital, New York City. Four additional cases have been studied, in which the roentgen findings have been suggestive of syphilis of the stomach, but a positive Wassermann reaction was not obtained. In this connection it may be well to quote the statement of Eusterman, of Rochester, Minn.: "There may be positive Wassermann reactions with gastric upset not due to syphilis, or the Wassermann test may not be obtained in a case of syphilis of the stomach; the Wassermann reaction may be absent following the use of salvarsan. The symptomatology is variable because the pathology is variable." [1]

FIG. 1. SYPHILIS OF THE STOMACH.

M. A. Female aged 23 years. Wassermann four plus. Note the rapid emptying of stomach. Exposure made in standing position two minutes after opaque meal. Note small size of stomach and dilatation of esophagus.

Eight of the present series of cases were reported by Downes and myself before the New York Surgical Society and published in the *Journal of the American Medical Association*, May 29, 1915; and three others were reported before this Society at its last annual meeting.

Pappenheimer and Woodruff, in a critical review of the cases reported up to 1907,[2] state that the number of authentic cases in the literature is very small. "Excluding the congenital cases of Aristoff, Chiari, Birch-Hirschfeld, Bittner, and Oberndorfer, there are but twelve which are above suspicion. A clinical analysis of so small a number is, of course, worthless, especially as the clinical data are meager or entirely wanting in the majority of them.

TABLE SHOWING AGE AND SEX INCIDENCE OF GASTRIC SYPHILIS.

Years	No.	Males	Females	Treatment	Operation
10 to 20.....	2	1	1	1	1
20 to 30.....	4	2	2	3	1
30 to 40.....	7	5	2	6	1
40 to 50.....	3	3	0	2	1
50 to 60.....	1	1	0	1	0
60 to 70.....	1	1	0	0	1
70 to 80.....	1	1	0	1	0
Total.....	19	14	5	14	5

[1] Discussion of Smithie's paper on "Syphilis of the Stomach Based on Study of Twenty-six Cases." *Jour. A. M. A.*, August 14, 1915, p. 572.

[2] *Bellevue Hospital Reports*, 1907.

* Read before the Seventeenth Annual Meeting of the American Roentgen Ray Society, Chicago, September 29, 1916.

All the cases have been in males, the age ranging between 23 and 52 years. Epigastric pain and vomiting, both intensified by the ingestion of food, appear to have been prominent symptoms. There is no record of hematemesis—no analysis of the gastric contents."

They added one case,—a male, aged 32, admitted to the service of Dr. George Roe Lockwood at Bellevue Hospital. The patient died of gastric hemorrhage. Autopsy disclosed a large blood clot in the stomach, which on removal revealed an extensive serpiginous ulceration, involving an area of approximately 6 x 5 cm, situated on the posterior wall and extending across the lesser curvature for a distance of several cm. Two eroded stumps of vessels were found projecting within the margin of the ulcer. The wall of the stomach, from the pyloric ring beyond the limits of the ulcer showed marked thickening, due to firm, whitish, infiltrating tissue. On cross-section, the involved portion of the stomach measured about 7 mm in diameter. The peritoneal surface was normal. Microscopical examination showed collections of lymphoid cells, arranged chiefly about the vessels; the cellular elements between the connective tissue fibers were comparatively scanty and consisted principally of epithelioid cells with pale vesicular nuclei. The liver showed areas of coagulation necrosis, containing large giant cells with twenty or more oval nuclei at the periphery. The pancreatic, mesenteric, and perigastric lymph nodes showed distinct evidence of syphilitic lesions. Pieces of tissue from the liver and mesenteric lymph nodes, after prolonged fixation in Kaiserling's solution, were stained according to Levaditi's fixation method for the spirocheta pallida. A few atypical moniliform threads were found, but no typical spirals.

In the discussion of Pappenheimer's case, Dr. E. Libman reported a case in which re-

FIG. 2. SYPHILIS OF THE STOMACH.

M. A. Female aged 23 years. Wassermann four plus. Note the very small size of the stomach and the remarkable outline of the entire duodenum owing to retraction of the stomach and the rapid emptying. (Exposure made five minutes after opaque meal. Same case as Fig. 1.)

FIG. 3. SYPHILIS OF THE STOMACH.

M. A. Female aged 23 years. 2½ years after treatment. For comparison with Figs. 1 and 2. Note the less rapid emptying time of the stomach. The deformity of the stomach persists. The capacity is greater, suggesting that the walls are less infiltrated. (Exposure made three minutes after opaque meal.)

section of the pylorus was done for supposed carcinoma, but the inspection of the gross specimen suggested the diagnosis of syphilis by exclusion. There were irregular ulcerations, and scars at the base of the ulcer. The patient died two days after operation, and a typical syphilitic liver was found. The microscopical examination was in accordance with the diagnosis. (See *Proceedings N. Y. Pathological Society*, 1906–7.)

In the course of another discussion on syphilitic lesions before the New York Pathological Society, Dr. Horst Oertel emphasized the occurrence of a very large number of giant cells in gummata, and stated that in his opinion this did not at all indicate any association with a tuberculous process, but that they probably resulted from a fusion or overgrowth of granulomatous cells. This is a most important observation, as reports show that a number of pathologists have been inclined to at once diagnose tuberculosis of the stomach when such lesions were found, but on further study and the failure to demonstrate tubercle bacilli, have admitted the syphilitic nature of the process. Of course the demonstration of the spirocheta pallida would be conclusive evidence, but so far this has not been accomplished, unless we accept Pappenheimer's possible findings in his case.

In this connection, the observations of Warthin, of Ann Arbor, relative to the presence of spirocheta pallida in interstitial pancreatitis are very suggestive. Warthin claims that his findings will necessitate the revision of the entire subject of syphilis of the abdominal organs. In the past, pathologists have considered syphilis present only when gummata were found. Warthin shows that a much more common syphilitic change is a very mild connective tissue proliferation associated with the presence of spirocheta pallida; so that in the future it will be necessary to bear this in mind. Symmers,[3] for example, in summarizing 4,880 necropsies at Bellevue Hospital, in which the diagnosis was based upon anatomic lesions alone, records no case of syphilitic pancreatitis, and only one case of syphilis of the stomach,—that reported by Pappenheimer and Woodruff, above referred to.

Jerome Meyers made an important contribution to this subject in his paper read before the New York State Medical Society in 1912. He drew the following conclusions:

"1. It is a rare manifestation of syphilis, congenital or acquired, occurring mostly in males, especially in the fourth and fifth decades, but also at almost any age.

"2. Its pathology is characterized by (1) multiplicity of lesions in many organs, (2) by variety and plurality of lesions in the stomach itself.

"3. Its symptomatology corresponds to the pathological findings; it presents no unanimity of symptoms.

"4. There are four symptoms which are, however, fairly common, singly or combined. These are (1) pain, especially immediately after eating; (2) emaciation; (3) tenderness; (4) hemorrhage.

"5. Clinically, we should not divide cases of gastric syphilis too strictly, as an exact diagnosis of the form of lesion is often impossible, except by operation or autopsy.

"6. We may classify syphilis of the stomach under (1) ulcer in any part of the stomach and its results; (2) gumma in any part and its sequelæ as a tumor; (3) widespread infiltrations of gummatous or more fibrous character leading to deformity, cicatrization, or involvement of the peritoneum or neighboring organs; (4) a combination of two or more of these.

"7. The diagnosis is extremely difficult, as a rule. If there is a clear history of syphilis, or if the Wassermann is positive, the diagnosis should be comparatively simple.

"8. The proper diagnosis is extremely important, as exitus may occur through hemorrhage, inanition, or stenosis, when

[3] "Anatomic Lesions in Late Acquired Syphilis," Douglas Symmers, *Jour. A. M. A.*, May 6, 1916, p. 1462.

timely intervention could have cured. Even when finally properly diagnosed, many of the cases have suffered delays through an originally false diagnosis and treatment.

"9. Any form of mercury or the iodides give as brilliant results as are to be found in the practice of medicine."

Eusterman reported twenty cases before the American Gastro-Enterological Association, May, 1916, and emphasized the invaluable assistance afforded by the roentgen ray and serology.

Derr and Reu, members of this Society, have each, in a personal communication, contributed a case.

Morris reports a case in the New York State *Journal of Medicine*, May, 1916.

Notwithstanding the number of recently reported cases, I believe the relative frequency and importance of the condition is not yet thoroughly appreciated. The Roentgen examination and the Wassermann reaction provide the data necessary to establish the diagnosis in doubtful cases and should never be omitted.

Roentgen ray findings may be classified as follows: (1) Diminished size, accompanied by almost immediate evacuation of most of the stomach contents. Traces of food, however, may remain high up at the cardiac end for six hours, or longer.

(2) Dumb-bell shaped deformity—due to stenosis of the middle of the stomach over a *wide* area—in contradistinction to the hour-glass stomach resulting from a cicatrized ulcer involving only a circumscribed area. In this type there is apt to be a compensatory dilatation of the esophagus to offset the diminished stomach capacity.

(3) The infiltration may involve only the pyloric region, in which case the findings may closely resemble those of cicatrized ulcer in the same region, and may be accompanied by dilatation of the stomach.

FIG. 4. SYPHILIS OF THE STOMACH.

D. F. Male aged 54 years. Wassermann four plus. Note the peculiar smooth outline of the deformed part of the stomach and the pyloric portion; this would tend to distinguish it from the irregular appearance seen in new-growth. Note the rapid emptying, exposure being made *three* minutes after taking opaque meal. Complete relief by medical treatment. Well two years later.

FIG. 5. SYPHILIS OF THE STOMACH.

H. D. Female aged 14 years. Wassermann four plus. This shows the characteristic "dumb-bell" deformity of the stomach associated with dilatation of the esophagus. Gastroenterostomy was performed on account of extreme stenosis. Well three years later.

FIG. 6. DIFFERENTIAL DIAGNOSIS.

A. E. Female aged 31 years. "Dumb-bell" shaped stomach due to spasm. Confirmed by operation. Deformity somewhat simulating a syphilitic infiltration.

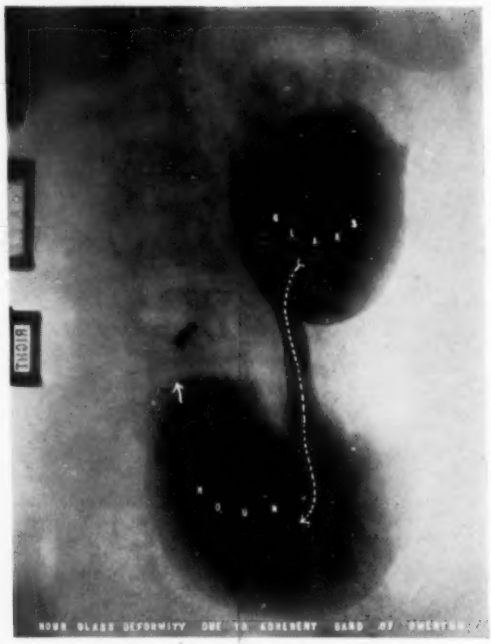


FIG. 7. DIFFERENTIAL DIAGNOSIS.

M. S. Female aged 43 years. "Dumb-bell" shaped stomach due to a broad band of omentum crossing stomach and adherent to the cicatrix from a negative exploration of gallbladder. Deformity quickly relieved at operation by cutting omentum. Deformity somewhat simulating that seen in syphilis.

(4) Filling defects about the greater curvature or any portion of the stomach, in which case the findings may closely resemble those of new-growths.

Congenital cases may escape diagnosis, owing to the fact that syphilis may not be suspected. Fournier and Oppenheim report cases of congenital syphilis in which the manifestations were delayed until twenty-eight and forty years of age, respectively.[4]

The diminished acidity of the gastric contents and the absence of free hydrochloric acid found in a number of the cases, especially in type 1, may be explained by the rapid emptying of the stomach. In type 2, it may be explained by the withdrawal of contents from the cardiac end or from the dilated esophagus.

Having established a positive or even a probable diagnosis, antisyphilitic treatment should be immediately instituted,—salvarsan, mercury, and the iodides. Prompt response may usually be expected, but in cases of long-standing cicatrization, surgical intervention may be necessary to effect a cure. Gastro-enterostomy best meets this indication.

[4] Fullerton: "The Significance of Syphilis in Obstetrics." *Am. Jour. of Obstetrics*, July, 1916.

INDICATIONS FOR SURGICAL INTERVENTION IN GASTRIC CANCER*

BY LEWIS GREGORY COLE, M.D.

Professor of Roentgenology, Cornell University

NEW YORK

WE have considered the method, scope and accuracy of the roentgen diagnosis of gastric cancer and the value of the negative diagnosis of such lesions at previous meetings of the Society, and many of the cases used to illustrate this article have been used in previous articles to demonstrate the method, scope and accuracy of the roentgen diagnosis in gastric cancer, but now we are going one step further and consider the indications for surgical procedure that are evidenced in the roentgen findings.

There is one fundamental question that is asked regarding nearly every case that is referred for a roentgen examination. It is expressed in different ways. One patient will say: "I have been sick so long that I certainly hope you will find something to be cut out." Another will say: "I do not care what you find; I will not be operated upon." The physician asks: "Are there any indications for surgical procedure?" And the surgeon asks: "Well, what can I do?"

Lest what I have to say seem radical to some, we will briefly consider a few simple cases, not in the gastro-intestinal tract, where the roentgen indications for surgical procedure are self-evident. If, for instance, we observe in a plate a needle in the bottom of the foot, point up, there is no question of the indication for its removal. Or, with a bullet in the soft parts of the thigh, there is no infection, and the wound is closed. There is definite roentgen evidence of the bullet, but no roentgen indication for its removal.

The first case is that of a girl who was shot in the neck with a 22 C bullet. The case was reported by Dr. Coley. The girl was paralyzed from the neck down, and the roentgen evidence showed that the bullet had lodged between the laminæ of the vertebra, pressing on the cord but probably not impairing its function. There was definite roentgen indication for surgical procedure in this case owing to the location of the bullet. If it had gone one-half inch further there would have been no indication for surgical procedure except to prove the accuracy of the roentgen examination, and if it had gone one-half inch less deep there would have been no more roentgen indication for its removal than for the removal of the bullet in the thigh.

In cases of fracture with perfect apposition of the fragments there is no question of surgical procedure. A dressing is applied and an attempt made to keep the fragments in good position, but in cases of fracture with marked deformity the surgeon follows the roentgen indication in his attempt to reduce the deformity, or, if this is impossible, he uses the roentgen findings in determining whether or not an open operation is necessary.

A clear-cut localized lung abscess or localized interlobar empyema, so centrally located that it gives us no physical signs, may remain unsuspected until detected roentgenographically and then the roentgen indications for surgical procedure are absolute.

In all of these conditions the roentgen indications for surgical procedure have been so obvious that it seems almost foolish to mention them as such, yet to one familiar with the roentgen evidence of gastric cancer, the indications for or against sur-

* Read at Seventeenth Annual Meeting of the American Roentgen Ray Society, Chicago, September 27–30, 1916.

gical procedure are just as clear, just as unmistakable, as in the conditions just mentioned.

When men such as I am addressing have seen in a series of roentgenograms that there is a growth involving the entire stomach, or a small indurated area or annular growth, discussion is unnecessary as to whether the roentgen evidence of the presence of such a lesion is of primary or secondary significance.

But to-day we take one step further and consider from a roentgen standpoint whether or not surgical procedure is indicated in those cases where we have made a positive diagnosis of gastric cancer or a lesion that can only be proved non-malignant by microscopic examination after its removal. To avoid misunderstanding we must clearly define what is meant by roentgen indications for surgical procedure. It means that the pathological process diagnosed, regardless of the condition of the patient, is amenable to surgical procedure either for surgical cure or palliation. It may well be that in an individual case roentgen indications for surgical procedure are very definite, yet the physical condition of the patient either from concomitant disease such as tuberculosis, nephritis, high blood pressure, old age, etc., contraindicates surgical procedure, so that the roentgen indications for surgical procedure, although present, cannot be followed. Therefore, before deciding to follow the roentgen indications for surgery, it is best to have the combined opinion of (1) the clinician who knows the physical condition of the patient; (2) the roentgenologist who knows the location and extent of the lesion and what can be accomplished by surgical procedure; and (3) the surgeon who should know both of these and his own ability and limitations.

In every case that comes to our office for consideration we make a negative or positive diagnosis of gastric cancer or precancerous indurated area and also state roentgen indications for surgical procedure. In only one case in five years has the roentgen diagnosis proved erroneous by surgery or autopsy and in this case the examination was incomplete and not made by me, although I did express a definite opinion as to the absence of a lesion.

Roentgen indications for surgical procedure in gastric cancer are the following:

If the growth is annular, not involving more than two and a half or three inches of the pyloric end of the stomach, an attempt should be made to do a pylorectomy. If, at the time of the operation, there are found extensive glandular involvement or liver metastases, the simpler procedure of gastro-enterostomy should be done.

If there is an indurated area, particularly with multiple nodules, involving a portion of the lesser curvature, particularly if it is near the pylorus, excision should undoubtedly be done.

If the growth is too extensive for complete removal and involves the pyloric end of the stomach, causing a stenosis which results in gastric retention, and if there is sufficient area of the stomach uninvolved to enable the surgeon to perform a gastro-enterostomy, such a procedure should be resorted to for palliation, and in the majority of cases it can be definitely determined before the operation whether posterior or anterior gastro-enterostomy can be performed.

If the growth involves a large portion of the lesser curvature or one of the walls of the stomach, or even if a relatively small area is involved high up near the esophagus, particularly if it involves the lower part of the esophagus, surgical procedure for removal is so difficult and the mortality so high in these cases that it should be attempted only after due consideration of these facts and only by those thoroughly capable of attempting this radical procedure. In this last group, gastrostomy would be indicated for its palliative effects provided the tumor growth involved the cardiac orifice.

Gastric cancer and precancerous indurated areas are placed in two groups and each of these is subdivided into the following two groups:

1. Inoperable
   - A. Operation is impossible.
   - B. Palliative operation is unnecessary.
2. Operable
   - A. For palliation.
   - B. For cure.

Approximately, one-half of the cases of gastric cancer that I have examined have

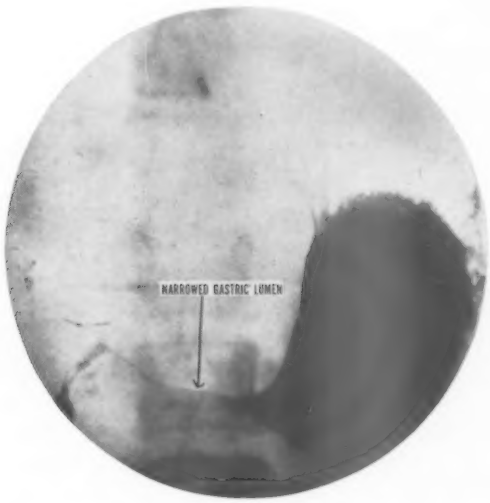


FIG. 1.—INOPERABLE: BECAUSE OPERATION IS IMPOSSIBLE.

been inoperable, and the roentgen evidence before operation indicated beyond a doubt that the case was inoperable. In about one-half of these inoperable cases, or 25% of all cases, the growth involved the pars pylorica in such a manner that it caused obstruction and, therefore, a gastro-enterostomy would have been desirable but so much of the gastric wall was involved that even an anterior gastro-enterostomy was impossible. This group is illustrated by three typical cases, where it is evident that there is not enough uninvolved space on the wall of the stomach to perform a gastro-enterostomy. Yet in each case the abdomen was opened and the growth viewed and palpated. In two of them nothing more was even attempted and in the third an anterior gastro-enterostomy was undertaken but the patient died before leaving the hospital.

CASE I. (Figure 1)

Roentgen Diagnosis: Extensive malignant growth involving the pyloric portion of the stomach and extending posteriorly along the lesser curvature.

Roentgen Indications: Pointed very forcibly to the fact that this condition was inoperable owing to the extensive involvement of the stomach wall, making a gastro-enterostomy impossible.

Operation: An exploratory laparotomy was done and the surgeon found the involvement so extensive that even a palliative gastro-enterostomy was impossible.

CASE II. (Figure 2)

Roentgen Diagnosis: Extensive nodular growth, which has become annular, near the pyloric sphincter and extending back for a distance of about two inches and then up the lesser curvature and to a smaller extent involving the anterior and posterior walls.

Roentgen Indications: The growth being so extensive that complete removal is impossible and a palliative gastro-enteros-

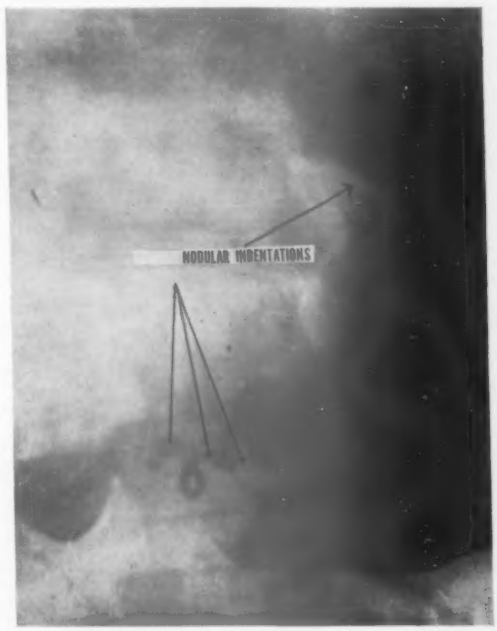


FIG. 2.—INOPERABLE: BECAUSE OPERATION IS IMPOSSIBLE.

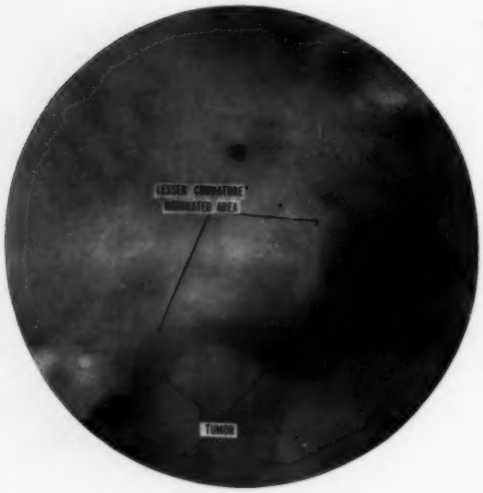


FIG. 3.—INOPERABLE: BECAUSE OPERATION IS IMPOSSIBLE.

tomy hardly possible, unless a small uninvolved space for anterior gastro-enterostomy can be found.

Operation: When the abdomen was opened, the surgeon found the condition practically as outlined in the roentgen findings. A posterior gastro-enterostomy was impossible. A small place was found and an anterior gastro-enterostomy was done.

CASE III. (Figure 3)

Roentgen Diagnosis: New growth involving the pyloric portion of the stomach, without the chronic nodular indentation of carcinoma.

Roentgen Indications: Clearly against an operation owing to the extensive involvement and the impossibility of even a palliative procedure.

Operation: This patient was subjected to an exploratory laparotomy. The surgeon after viewing the lesion, corroborated the roentgen findings and closed the abdomen, the case being inoperable.

In the other half of inoperable cases, the growth is so extensive that there is no hope for its successful removal. The growth usually involves the lesser curvature without obstructing the passage of food through the stomach and the patients die of constitutional symptoms or malnutrition before the growth causes gastric obstruction. In many cases the growth involves the posterior gastric wall so that only an anterior gastro-enterostomy can be performed. This group is also illustrated by three typical cases, in which it was desired either by the patient, his physician, or the surgeon, that there be a "look in" to the abdomen in the hope of proving the roentgen indication against surgical procedure erroneous.

CASE IV. (Figure 4)

Roentgen Diagnosis: Carcinoma of the lesser curvature of the stomach with adhesions involving the cap and extreme pyloric end of the stomach.

Roentgen Indications: Radical procedure was impossible due to the extent of the involvement, while a palliative procedure was not indicated in the absence of a definite obstruction.

Operation: This patient was subsequently subjected to an operation, the exact nature of which we were unable to determine, and lived only one or two months after the operation.

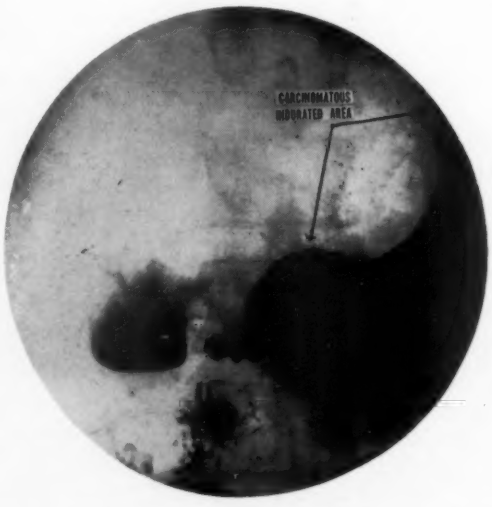


FIG. 4.—INOPERABLE: PALLIATIVE OPERATION IS UNNECESSARY.

CASE V. (Figure 5)

Roentgen Diagnosis: Extensive carcinomatosis of the lesser curvature of the stomach without obstruction.

Roentgen Indications: The roentgen indications for surgical procedure were negative, as the removal of the growth was impossible and there was no necessity for a palliative procedure.

Operation: Beyond an exploratory laparotomy in which only a gland was removed for microscopic examination, no surgical procedure was undertaken. Microsection of the gland removed confirmed the diagnosis of malignancy.

CASE VI. (Figure 6)

Roentgen Diagnosis: Positive diagnosis of an extensive carcinoma involving the lesser curvature of the stomach.

Roentgen Indications: This case was inoperable because the growth was so extensive that it would have been impossible to remove it and the patient would die of constitutional symptoms before the growth involved the pars media sufficiently to cause obstruction.

The operable cases are of more interest to all concerned. They are of two types:

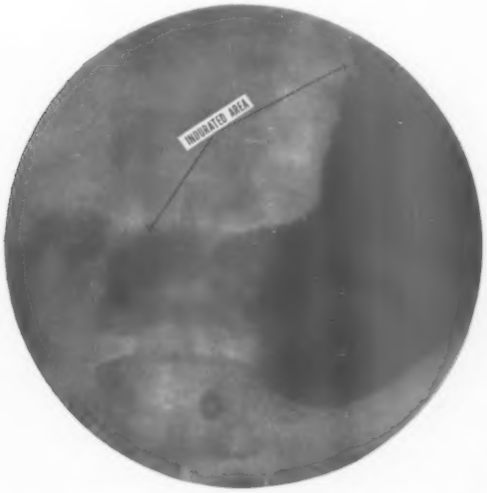


FIG. 5.—INOPERABLE: PALLIATIVE OPERATION IS UNNECESSARY.

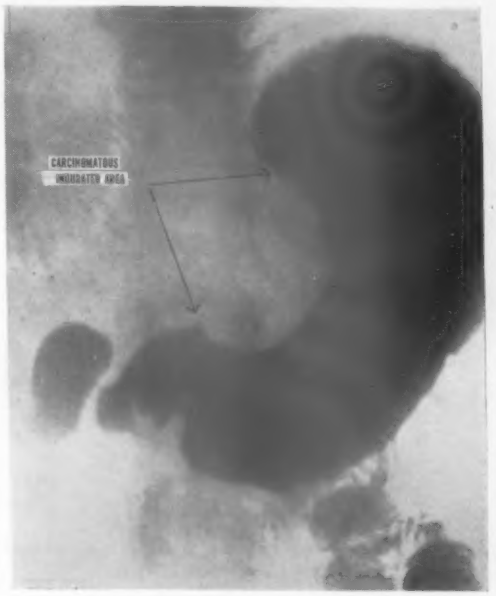


FIG. 6.—INOPERABLE: PALLIATIVE OPERATION IS UNNECESSARY.

(1) operable for palliation; (2) operable for cure. In approximately 75 per cent. of the operable cases, which are proved to be malignant at the time of operation, nothing more than a palliative gastro-enterostomy can be performed, and in many of these cases the desired palliation is not obtained. Nevertheless, the operation is justifiable even if the desired relief should not follow. This group is illustrated by only two typical cases where temporary relief has been secured.

CASE VII. (Figure 7)

Roentgen Diagnosis: Extensive annular carcinoma involving the pyloric portion of the stomach.

Roentgen Indications: Decidedly in favor of a palliative surgical procedure.

Operation: The operative procedure was delayed for several months. When the patient was finally operated on, the surgeon found it impossible to do a posterior gastro-enterostomy owing to the rapid progression of the lesion. An anterior gastro-enterostomy was done but the patient lived only a short time.

FIG. 7.—OPERABLE: FOR PALLIATION.

CASE VIII. (Figure 8)

Roentgen Diagnosis: Malignant new growth involving the lesser curvature surface of the pyloric portion of the stomach.

Roentgen Indications: Owing to the location and character of this lesion, the roentgen evidence pointed to the fact that obstruction was likely to occur before a fatal termination from constitutional effects took place. As a consequence, the roentgen indications were favorable for palliative surgery.

Operation: A gastro-enterostomy was performed under very great difficulties. The patient was made more comfortable for a period of several months.

This leaves 25 per cent. of the operable cases (only 12 per cent. of the total number of gastric cancers), where there is any hope for surgical cure by resection of part of the stomach or by pylorectomy. These are illustrated by seven typical cases of relatively early gastric cancer.

There is also a group of operable cases where the primary lesion in the stomach is limited to the pylorus or to such a small area in the gastric wall that it could be surgically removed, but there exists such an extensive secondary involvement in the glands and metastases in the liver that the removal of the growth could not possibly be of any benefit to the patient. Such cases should be considered under the group "Operable for cure," giving them the benefit of the doubt; and if at the time of operation an extensive glandular involvement or metastases in the liver are found palliative procedure may be instituted; or if there are no obstructive changes, the abdomen may be closed without resorting to surgical procedure.

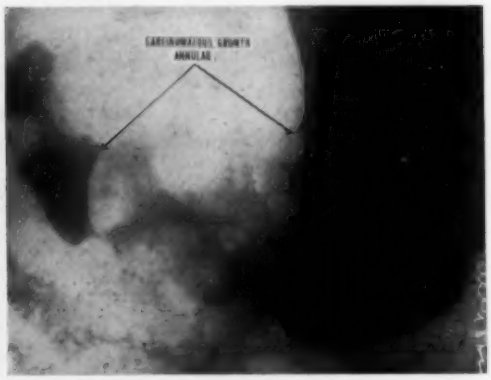


FIG. 8.—OPERABLE: FOR PALLIATION.

FIG. 9.—OPERABLE: FOR CURE.

This small group of cases appeared to be one bright spot in the surgical treatment of gastric cancer, but when I tell you that in 70 per cent. of these cases in which an attempt was made to remove the growth, the patient died before leaving the hospital, even this small bright spot is dimmed.

Therefore, in my own personal experience the history of surgical treatment for gastric cancer has been a pathetic one.

CASE IX. (Figure 9)

Roentgen Diagnosis: Malignant growth involving the pars pylorica, producing definite pyloric obstruction.

Roentgen Indications: A pylorectomy for cure or a gastro-enterostomy for palliation was indicated. The general condition of the patient was so bad that the surgeon did not feel justified in even attempting the palliative procedure. The patient lived only two months.

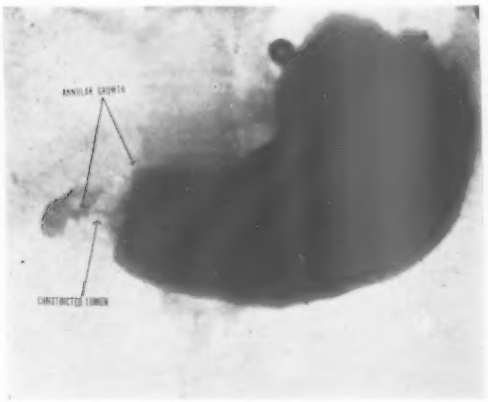


FIG. 10.—OPERABLE: FOR CURE.

CASE X. (Figure 10)

Roentgen Diagnosis: An annular new growth involving the extreme pyloric portion of the stomach and producing definite obstruction.

Roentgen Indications: Definitely for radical surgical procedure, as the amount of gastric wall involved was apparently small enough to permit a complete removal of the growth.

Operation: Owing to the extreme weakness of the patient, radical procedure was not considered advisable and only a palliative gastro-enterostomy could be done. The patient showed marked improvement following the operation and lived for a period of two and a half years.

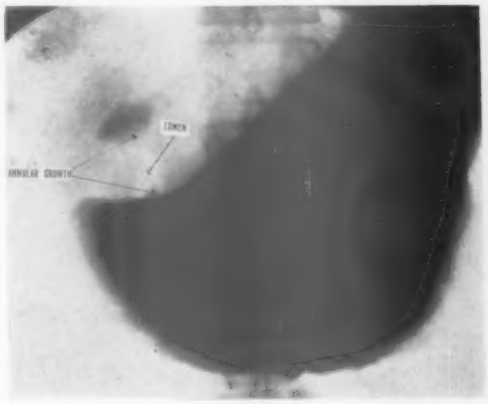


FIG. 11.—OPERABLE: FOR CURE.

CASE XI. (Figure 11)

Roentgen Diagnosis: Annular malignancy involving the pyloric end of the stomach, producing obstruction.

Roentgen Indications: Favorable for radical removal of the new growth owing to its location and extent.

Operation: A pylorectomy was attempted but owing to the extreme emaciation of the patient he did not survive the operation.

CASE XII. (Figure 12)

Roentgen Diagnosis: Saddle-shaped induration on the lesser curvature of the stomach with possible malignant changes.

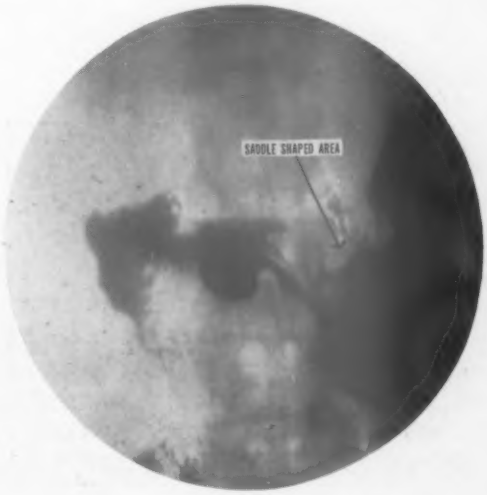


FIG. 12.—OPERABLE: FOR CURE.

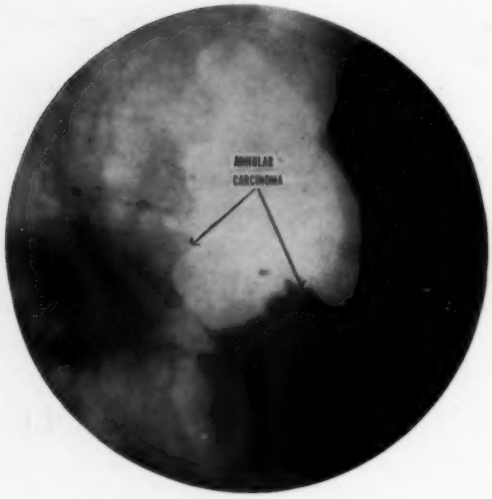


FIG. 13.—OPERABLE: FOR CURE.

Roentgen Indications: The roentgen indications were decidedly in favor of radical surgical procedure as an excision at this stage of the growth promised a definite result.

Operation: An excision of the indurated saddle-shaped mass on the lesser curvature was done. Microscopic examination of the removed growth proved its malignancy. The subsequent history of improvement which this patient has made justified the surgical procedure.

CASE XIII. (Figure 13)

Roentgen Diagnosis: Extensive carcinoma involving the extreme pyloric end of the stomach, more extensive on the lesser than on the greater curvature.

Roentgen Indications: The roentgen indications were for immediate removal of the tumor mass, and pylorectomy.

Operation: The pylorectomy was successfully done but the patient died suddenly on the second day.

CASE XIV. (Figure 14)

Roentgen Diagnosis: New-growth involving the pars pylorica.

Roentgen Indications: Favorable for surgical removal of the new-growth, as the area involved was small and a permanent result was possible through its removal.

Owing to the age and the clinical condition of the patient, surgical procedure was not considered advisable and the patient made some improvement on a well controlled diet, but died fourteen months later.

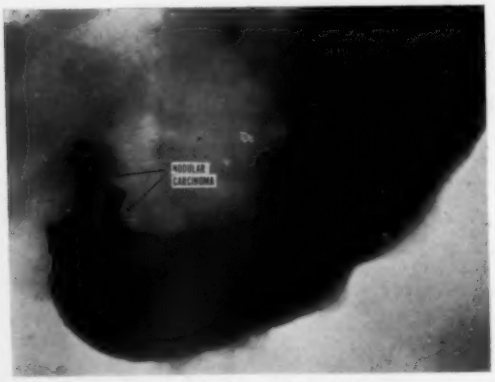


FIG. 14.—OPERABLE: FOR CURE.

FIG. 15.—OPERABLE: FOR CURE.

CASE XV. (Figure 15)

Roentgen Diagnosis: An extensive growth involving the lesser curvature of the stomach. This induration had a large depressed center which indicates that the original lesion was an ulcer.

Roentgen Indications: Favorable for removal of the entire tumor growth pro-

vided there was no glandular involvement or metastases.

Operation: This case was operated and the surgeon found such a wide-spread dissemination in the liver and glands that no operative procedure was attempted.

My conclusions from a study of gastric cancer are:

1. That in one-half of the cases the disease has progressed to such a stage even before roentgen examination, that nothing can be accomplished by surgical procedure either for palliation or cure.

2. That in the other half of the cases 75 per cent. may obtain palliation by surgical procedure and that in only 25 per cent. of these cases, or only 12 per cent. of the cases diagnosed by roentgen examination, can surgical procedure for cure be attempted. In 70 per cent. of these few cases in which attempt was made to remove the growth the patient died in the hospital.

DISCUSSION ON PAPERS OF DRS. LEWALD AND COLE

Dr. Edward H. Skinner, Kansas City, Mo.—I must again disagree with an eminent roentgenologist. If I had carcinoma of the stomach I would insist on a laparotomy no matter what the roentgenologist said. I would insist that some good surgeon actually see and feel my gastric organ and then pass judgment. If it were generally attempted to apply Cole's rules as to the operability or non-operability of gastric carcinoma, there would be too many mistakes. The roentgen knowledge given us has surgical values but I do not believe that we should pose as surgical advisers in these cases. We should be roentgen consultants. I want to say that we should not convey the diagnosis of operable or inoperable carcinoma to the patient. We can tell the surgeon and leave it to his judgment what should be done. It is not always fair to the patient to tell him, even if we are right.

Dr. Geo. C. Johnston, Pittsburgh, Pa.—Dr. LeWald's work on syphilis of the stomach is beautiful. The diagnosis in these cases is not always easy, but, say, you examine a man and you find evidence of extensive gastric carcinoma, so much that you are horrified. You look at him and he does not appear to be sick at all. If he had as large a carcinoma as is shown on the screen, he would be cachectic, weak, emaciated. Make a Wassermann test and you have the answer. That is the way I make the diagnosis.

Every year Dr. Cole gives us something good. This year he has given us something very good, but I feel as Dr. Skinner does. In every case of malignancy of the stomach which I see, if I have any reason to believe that it will become obstructive and if there remains a sufficient amount of gastric wall for the surgeon to be able to perform an anterior or posterior gastro-enterostomy, I insist that a laparotomy be done, because every one with suspected malignancy in the abdomen is entitled to an operation. It is a little thing compared with what he has. Moreover, every once in a while some such patient will be cured.

Dr. L. T. LeWald, New York.—The term "lesion" used by Dr. Cole is a good one for describing a deformity of the stomach. It is better than to commit ourselves to the statement that it is a new growth. In my original report there was only one case with a positive Wassermann, which I believed to be a case of malignant growth.

As to inoperability, I showed one case of carcinoma that remained alive a year after being pronounced inoperable. A laparotomy in that case might have done some good.

Dr. L. G. Cole, New York.—I hope that Dr. Skinner will never develop a carcinoma of the stomach or even an ulcer of the stomach.

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EDITORIALS

ROENTGENOLOGICAL EDUCATION

One phase of education in the roentgenological phases of medical and surgical practice lies within the scope of activities of every practitioner of roentgenology; viz., the familiarization of one's colleagues with the possibilities of this diagnostic and therapeutic means. The field of medical science has become so broad that it is scarcely possible for any man to keep up with the march of progress in more than a few of the special lines in which his interest centers. It is, therefore, appropriate that every *x*-ray worker should be of the greatest possible aid in disseminating knowledge of *x*-ray methods, in their clinical applications, among his fellow physicians. Readiness to give, when asked, the basis of an opinion, to make demonstrations and to give discourses when opportunity affords, is commendable.

It has been suggested to the Editor that another and perfectly proper method of helping one's colleagues to a better appreciation of the scope of *x*-ray work, would be the gift of a year's subscription to THE AMERICAN JOURNAL OF ROENTGENOLOGY. It is the purpose of the Editorial Board to make our Journal of the greatest use to the greatest number in elevating our ideals and maintaining high standards of *x*-ray diagnostic and therapeutic efficiency. It is our intention to publish not only articles of a more or less technical and special interest to experts, but also productions of a sort to be most helpful to the less experienced *x*-ray worker and to the clinician who to some extent appreciates the value of this newer method and wishes to become sufficiently familiar with it to recognize when it is carried out with appropriate technic.

MEMBERSHIP IN THE AMERICAN ROENTGEN RAY SOCIETY

The Chairman of the Executive Committee of the American Roentgen Ray Society has requested us to announce that the time for the presentation of applications for active membership in the Society expires on March 31, 1917. According to the revised Constitution and By-Laws, application for membership must be signed by two active members in good standing in the Society who are personally acquainted with

the applicant. It must be accompanied by a personal letter of recommendation from each of the members who signs it, and also by a similar letter from at least one practicing physician or surgeon in good standing residing in the applicant's immediate vicinity.

An applicant for active membership must have been a graduate in good standing of a recognized Medical College and have been engaged actively in the practice of roentgenology for at least three years after graduation, and must submit an original scientific paper on roentgenology to the executive committee, which, if approved, may be published in the Proceedings of the Society.

Applications must be sent to the Chairman of the Executive Committee at least six months before the meeting at which they are to be acted upon.

Application blanks may be secured from the Secretary, Dr. Wm. H. Stewart, 222 West 79th Street, New York.

Measurement of Roentgen Rays

The interest in roentgen measurement as evidenced by articles such as those of Voltz and of Weissenberg abstracted in this issue (pages 92 and 93) indicates a desire for improved methods of treatment which surely ought to be encouraged.

Before much can be accomplished, however, we must have a much better understanding of the elementary facts than seems to prevail at present.

First, it may be remarked that the introduction of methods involving needless complication and refinement can only defeat the ultimate purpose. At best, measurements can only serve as limit gauges to avoid over- or underdosage. Infinitely more must be known of the minute structure and function of the human system and of the effects of radiations before an accuracy remotely comparable with possible physical measurements will be achieved.

Much confusion would be avoided if well-known facts were considered in our attempts to rationally estimate the amount of radiation entering the body.

In one of the abstracts, reference is made to the mixture of rays emanating, etc., and one is told that this mixture is dependent on the course of the tension curve in the roentgen tube. If one considers the experiments of Hull comparing an *unfluctuating* voltage with the usual *rectified pulsating* current and notes the very *slight* difference in the wave-length intensity-curve, we may dismiss this phase of conjecture at once. Many experiments can be shown to demonstrate that differences of quality between different transformers (induction coil operation excepted), operated so as to give the same current and spark gap, are entirely negligible. As almost all tubes have tungsten targets, the distinction between "impulse" and characteristic rays is quite needless.

The author then raises the question of the effect of secondary rays on the measuring instrument. Surely, since the scattered rays are exactly like the beam received and are in exact proportion thereto, they can not endanger accuracy. As far as the photographic method is concerned, the true secondary or characteristic rays appearing as higher voltages are used in part to compensate for the decreased absorption of the shorter wave lengths.

It is to be hoped that the author's views on ionization methods will not be taken too seriously. The absorption coefficient of a gas varies with the wave length and only an average value can be given. The deduction of the *total energy* is certainly not easy and for the purpose of dosage is entirely useless.

The article on comparing dosimeters contains nothing very important. That readings vary with beam quality is surely not a disadvantage. One who has had experience with instruments of the ionometer type will hardly enthuse over its use in a busy office.

J. S. Shearer.

TRANSLATIONS & ABSTRACTS

SCHOENE, G., and SCHMIDT, E.: Is the Biological Effect of the Roentgen Rays Dependent on the Aggregate State of Rayed Cells? (*Deutsche Ztsch. f. Chir.*, Vol. 137, Nos. 1–3. Ref. *Berl. kl. Wchnschr.*, Oct. 2, 1916, p. 1113.)

The experiments communicated by the author establish the fact that frozen tumor tissue outside the body may lose some of its power of development under the influence of roentgen rays. The experiments, however, do not go to show whether the effect of roentgen rays is stronger or weaker on frozen than on non-frozen tissue. The question of sensitization or desensitization of frozen tissue outside the body will have to be decided by experiments in which rays must be brought to impinge on the border between frozen and non-frozen tissue.

VOLTZ, F.: Measuring Devices of Roentgen Rays and Their Comparableness. (*Fortschr. a. d. Geb. d. Roentgenstr.*, Vol. XXIII, No. 6, p. 465. Ref.: *Zentralbl. f. Roentgenstr.*, 1916, Nos. 5 and 6, p. 162.) (See Editorial, this issue.)

The great variety of measuring methods to determine the quality and quantity of roentgen rays, and the consequent chaos, are more and more felt to be untenable in the practical application of the roentgen technic. Voltz examines into the question in what way it might be possible to establish some sort of uniformity. The object of dosimetry is to correctly estimate the energy of roentgen rays absorbed in the human tissue so that the identical energy may be reproduced and with it a certain desired biological effect. A distinction must be made between the biological effect upon cells and the physico-chemical effect upon measuring implements. A biological effect can not be measured at all with a physico-chemical measuring implement unless it can be shown that there is a very definite relation between these two effects. In determining the quality, i.e., the hardness of the rays, there should be a clear conception as to the mixture of rays emanating from the roentgen tube. Under the varying working conditions of roentgen installations, mixtures of highly diversified wave lengths are produced, aside from the fact that two special kinds of rays are to be distinguished: the impulse rays and the characteristic rays. The impulse rays are brought about by the electrons in the tube, having taken up energy in consequence of the electric forces in the tube, using this energy for building up a power field as they impinge upon the anticathode. The hardness of the impulse tension is therefore proportionate to the tension of the tube electrodes; i.e., the sphere of influence of the wave lengths of the impulse rays is dependent on the course of the tension curve of the roentgen tube. As this is very complicated, the roentgen ray spectrum is likewise very complicated. The impulse rays are still superimposed by the spectrum of the characteristic rays. The reason is that the anticathode is excited by the impingeing of the electrons in such a way that roentgen rays are emitted the wave lengths of which are different for each kind of metal. From the fact that the composition of the wave lengths of the characteristic rays is immutable with a definite anticathode, it follows that the tension curve of the tube is a relatively sufficient measure for the spectral composition of the mixture of roentgen rays.

In determining the quantity of roentgen rays, the production of secondary rays in the measuring instrument and in the human cells is of the greatest importance. It has been shown that a cell is affected more in proportion to the force of the secondary rays and to the younger age of the cells. The question is what kind of secondary rays may be produced. These are: diffuse rays, secondary roentgen rays and corpuscular rays. The diffuse rays are by their nature identical with the primary rays and are therefore possessed of the nature of light. The harder the incident rays, the harder will be the diffuse rays. The secondary roentgen rays are fluorescent rays; as the atomic weight increases, the proportion of the secondary roentgen rays to the primary rays becomes greater. In this respect, Stokes' optometric rule holds good: A substance which may be excited by light becomes fluorescent only when the exciting light has shorter wave lengths than the excited. If a roentgen ray impinges upon a chemical compound, the nature of the secondary rays is only

determined by the nature of the chemical elements contained in the compound and not by the manner of the chemical cohesion.

For our purposes we have principally to consider the influence of the secondary rays of the elements which are contained in the substances, on the chemical and physical changes of the material used in the construction of the roentgen ray measuring devices, i.e., silver, aluminum, etc. The secondary corpuscular rays have the character of the cathode or beta rays. They are more easily absorbed, and their velocity is the greater the harder the roentgen rays; and the quantity of the rays is the larger the greater the atomic weight of the rayed substances. The secondary corpuscular rays are related to the diffuse rays in the same way as the rays produced on the anticathode to the cathode rays.

The question is in what way the secondary rays exert any influence in the methods of measuring the quality and quantity of the roentgen rays. Some instruments which measure the hardness of the rays compare the penetrability of a substance of various thicknesses, as for instance of an aluminum terrace or an aluminum wedge. All of them are serviceable only when the working technic and conditions remain unchanged. Any method which depends on the blackening of a silversalt is impracticable, because secondary rays are produced in the silversalt which, according to the position of the maximum intensity in the primary roentgen ray spectrum occur in varying quantities. An unobjectionable determination of the hardness of the ray mixture can, therefore, only be attained by measuring the tension. The spectrum is sufficiently defined by the tension curve of the tube. Another measuring method might consist in the determination of the physical coefficient of absorption or of the half-value-layer which is closely related thereto.

In the various measuring methods of dosimetry, the extent of the effect of the roentgen rays upon the measuring implement is dependent on the number of the electrons engendered, i.e., the extent of the secondary cathode rays. But since a selective absorption occurs in the silversalts, there is a source of error in the measuring method based on the blackening of silversalts. The measuring methods which avail themselves of the ionizing effort of the rays, have to overcome the conservative opposition of a large number of roentgen technologists. And yet, these methods are the only ones by which an unobjectionable measurement can be accomplished. The saturation point in the ionization chamber is independent of the hardness of the rays and directly proportionate to the ray energy absorbed in the volume unit of the gas. If the absorption coefficient of the gas is known, the total energy of the rays can be deduced therefrom.

The attempts to relate the various measuring methods to each other and to establish a numerical relation between the various scales will only be successful if the reagents behave in an absolutely uniform manner toward the rays. A comparison of the various dosimeters with each other is therefore impossible.

WEISSENBERG, K.: Dosage and Superficial Energy. (*Fortschr. a. d. Geb. d. Roentgenstr.*, Vol. XXIII, No. 6, p. 526. Ref.: *Zentralbl. f. Roentgenstr.*, 1916, Nos. 5 and 6, p. 161.) (See Editorial, this issue.)

By superficial energy is understood the quantity of roentgen energy received on a superficial unit, and by dosage is understood the indication of any one of the recognized dosimeters. The author examines into the question as to how these two values can be related to each other and in how far the figures given by the various dosimeters can be compared with each other. He finds that the figures of the dosimeters are in a large measure dependent on the hardness of the roentgen rays and that there is no such thing as a constant relation between the figures of the various dosimeters. There is no sense, therefore, in establishing comparative dosimetric tables. The reason, in part, lies in the fact that the roentgen rays produce variable quantities of secondary rays in the various dosimeters owing to the difference in the material they consist of. In order to obviate the difficulties due to the incompatibility of the dosimeters, the author suggests omitting dosimeter readings altogether and stating superficial energy instead. He has devised a graphic procedure by which it is possible to convert the figures of a good dosimeter into superficial energy. This presupposes a dosimeter which (1) is free from specific secondary rays, (2) has a thin absorbing layer and (3) works with a pointer like the hand of a watch. These requirements are in his opinion best met in the ionometer. The method of conversion is clearly shown in an example.

SCHLECHT, H.: *X*-Ray Diagnosis of Tumors of the Large Intestine. (*Med. Klin.*, Sept. 24, 1916. Ref. *N. Y. Med. Jour.*)

Schlecht states that in a considerable proportion of cases of tumors of the large intestine diagnosis by means of the *x*-ray and bismuth or barium meal is an easy matter, but there is a small proportion of cases in which the passage of the meal is not obstructed or may even be abnormally rapid, and in which there are no shadows suggestive of neoplasm. In these cases the diagnosis may be rendered easy by the use of a bismuth or barium enema, and the *x*-ray observation of its course. Where a tumor is present there will usually be an obstruction to the passage of the enema at the site of the growth with overfilling and dilatation of the distal portion of the large intestines and the desire to expel the enema. The occurrence of these three symptoms is very characteristic of tumors of the large intestine, so much so, in fact, as to be almost pathognomonic of their presence. If they are combined with the passage of blood, either occult or gross, a malignant neoplasm is almost certainly present.

WEIL, ALBERT E.: Radiotherapy in Peripheral Tuberculous Adenopathy. (*Paris méd.*, Sept. 23, 1916. Ref. *N. Y. Med. Jour.*)

Weil asserts that by virtue of recent improvements in *x*-ray technic, through which treatment can be restricted largely to the more penetrating rays of short wave length and much larger doses used without exciting dermatitis, there is now no form of tuberculous adenopathy in which *x*-ray treatment is not indicated. The *x*-rays melt down and cure the largest lymphatic masses, even without the aid of general treatment or heliotherapy; very rapidly when the glandular masses are semihard or recent, less rapidly but with equal certainty when they are hard and confluent. In closed suppurative cases, aspiration with a fine needle should preferably proceed to remove the pus which forms an obstacle to the rays. In suppurating cases with sinuses and skin ulceration, the pus and necrotic tissue should likewise be withdrawn beforehand, the bridges of skin separating sinus openings sometimes cut through, and iodin applied from time to time to combat superadded infection. The *x*-rays remain, however, the main therapeutic factor. Weil divides the skin over the affected glands into as many districts as are required, so that each unit of surface treated shall receive approximately the same dose of rays. Over each area hard rays are passed through a four mm aluminum plate, measuring eight or nine on the Benoist radiochromometer. The sittings in each region are repeated until every portal of entry has received ten, twelve, or even fourteen H units of rays. The total amount is administered in five or six consecutive days. Marked reactions with high temperature do not follow such a procedure, except occasionally in certain soft, rapidly developing gland involvements. Neither is there ever noted a rapid growth of the lymphatic masses, or a general spread of the tuberculous process; such results as these, sometimes noted formerly, signify insufficient doses. Weil reports a number of cases, with photographic reproductions, illustrating the excellent results obtained from the use of rays in cervical adenitis.

WILMS: The Effect of the Roentgen Rays on Inflammatory Carcinoma. (*Muench. med. Wchnschr.*, Vol. 63, No. 38, Sept. 19, 1916, p. 1362.)

Wilms endeavors to answer the question why roentgen treatment has a much more favorable effect in some cases of carcinoma than in others. While the superficial locality and the cell resistance in individual cases will play an important part, Wilms believes that the influence of the roentgen rays upon the inflammatory processes which frequently accompany carcinoma is a factor in the case. It has been observed again and again that carcinomatous growth is strongly incited under the influence of an inflammation or where an inflammatory process has been the starting point of the malignancy. Among these are carcinoma of the tongue following in the wake of decubital ulcer, and some forms of rectal and cervical carcinoma. As regards carcinoma of the cervix especially, it is well known that the extensive inflammation which usually develops around the carcinoma is very favorably influenced by the roentgen treatment of the carcinoma, with the consequence that the nucleus of the malignant growth can be recognized much more clearly than before roentgen treatment was begun. Now, Wilms opines, if the inflamma-

tion which accompanies or causes the carcinoma is an essential factor for its development in the organism, then a cure of the carcinoma by means of roentgen therapy would be facilitated after removal of the inflammation, because the protective agents of the organism, increased perhaps by the fermentative and autolytic action of the roentgen rays, might attack the carcinoma more energetically than before.

Wilms does not deny, in proposing this theory, that the influence of the rays upon the cells themselves is of material importance, but it would seem to him that this does not exhaust everything in the way of remedial forces which is available in the fight against carcinoma. He does not propound this idea as a proved fact but as an attempt to explain why roentgen rays have a strikingly favorable influence upon cervical carcinoma. It should therefore be worth while following up as a working hypothesis.

SCHLECHT, H.: Symptoms of Duodenal Stenosis in the Presence of Abnormal Ligamentous Adhesions of the Gallbladder (ligamentum hepatocolicum). (*Muench. med. Wchnschr.*, Vol. 63, No. 38, Sept. 19, 1916, p. 1353.)

The author cites Kojetzny's description of the so-called ligamentum hepatocolicum as follows:

"Normally, there is no connection between the gallbladder and the neighboring organs except the liver. Its surface is absolutely free up to the cystic duct which presently descends into the hepatoduodenal ligament. The latter contains the afferent and efferent hepatic vessels. The free margin of this ligament may, however, protrude far enough to reach the gallbladder in an upward, and the transverse colon in a downward direction (Merkel-Henle). The gallbladder and transverse colon communicate by means of a broad peritoneal fold, stretching between these two organs like a band. This peritoneal fold which is the direct continuation of the hepatoduodenal ligament, is but scantily mentioned in the textbooks under the appellation of hepatocolic ligament. This ligament, starting in a narrow form, often extends to the fundus of the gallbladder. Traversing the duodenum and colon, it fuses with the omentum. There is often a second anomaly in the form of a ligamentous adhesion between gallbladder and liver, which may be referred to as a mesenteriolum of the gallbladder. The hepatocolic ligament varies in shape; it may be narrow, ligamentous or roof-shaped at the extreme margin, giving the transverse section a T-shape. In these cases the fundus of the gallbladder is often grasped by two shanks."

Kojetzny proves that these changes are not inflammatory but congenital, having found these ligaments in about fifteen to twenty per cent. of new-born infants.

The author (Schlecht) describes the case of a 38-year old married woman, giving both the clinical and roentgenological findings, of which the following are the more important details:

Clinical: Heart, lungs and nerves negative. Abdomen soft, no tension, rectus diastasis. There is an extremely painful place in the region of the gallbladder. A tumor-like resistance, suggesting the kidney, is felt in bimanual palpation with the hand flat on the abdomen. The region of the bladder and along the right ureter is also somewhat susceptible. The urine shows traces of albumin and isolated leucocytes, but no biliary pigment. Cystoscopic findings normal.

Oct. 16.—Sudden violent pain, especially in the region of the gallbladder. The pains radiate into the right shoulder and toward the back. There is a feeling of formication in the left foot. Morphium.

Oct. 17.—Pains not quite subsided. Pressure point in the gallbladder region persists.

Oct. 18.—The paroxysm has passed, but a certain susceptibility to pressure of the right kidney remains.

Oct. 24.—Examination of stomach contents: free HCl 8, total acidity 50.

Oct. 30.—Another violent paroxysm. The entire abdomen highly sensitive to pressure. Morphium.

Nov. 3.—Paroxysm over. Wassermann reaction positive.

Nov. 4.—Violent paroxysm. Abdominal and renal regions very susceptible to pressure. No bile pigment in urine. Roentgen examination of the ureters: no calculi.

The positive Wassermann reaction suggested tabetic crises, especially as the history revealed stabbing pains in the right leg during last year.

Nov. 9.—Paroxysm with pain, localized in gallbladder region. Vomiting. No shadows of blood corpuscles in the urine.

Nov. 11.—Clinical diagnosis: Suspected cholelithiasis.

Roentgen Examination, Nov. 11.—Deglutition normal. Filling of stomach normal. Descent of greater curvature. Transverse diameter of stomach somewhat exaggerated. Peristole normal. Peristalsis perfectly normal. No antiperistalsis. Nevertheless, about one-quarter of the bismuth meal was found in the stomach after six hours. Normal intestinal passage after 24 hours.

Nov. 12.—Barium sulphate emulsion given on an empty stomach. Effleurage into the duodenum. Persistent considerable filling of the duodenum to the descending and horizontal inferior parts. Peristalsis very active; distinct antiperistaltic waves of the duodenum. This permanent filling together with active peristalsis persists for a considerable time. When the contents passed into the small intestine, repeated effleurage induced the same manifestations. Pronounced susceptibility to pressure along the course of the duodenum, especially in the pars horizontalis inferior and descendens, but also in the region of the gallbladder outside the intestine.

In view of the clinical statement that the colon was occasionally painful to pressure, irrigoscopy was carried out. The large intestine filled itself in a normal way to the ileocecal valve except the first part of the transverse colon below the gallbladder and duodenum which did not fill completely, not even with manual assistance.

Roentgen Diagnosis: Motor disturbance of the stomach. Intermittent duodenal stenosis. Duodenal ulcer not excluded; in fact, the findings may point that way. Interpreted in conjunction with the clinical findings, however, an affection outside the duodenum (gallbladder?) is more likely, consisting probably of adhesions, especially of the duodenum.

The final clinical diagnosis was: cholelithiasis, duodenal adhesions.

With this diagnosis the patient was referred for operation.

Operative Findings.—Between the gallbladder and colon, there is a band-like connection, attached on a narrow base along the entire length of the gallbladder, traversing the duodenum and terminating at the colon. This band is a direct continuation of the hepatoduodenal ligament. The gallbladder is normal, its peritoneal covering free from inflammatory changes. No stones in the gallbladder. Stomach and duodenum normal. Appendix neutral. Appendectomy. Separation of the ligamentum hepatocolicum which shows no inflammatory changes.

The patient remained free from complaints for nine months, when fresh paroxysms occurred which were emphatically suspected to be due to renal calculi. A roentgen examination revealed three shadows the size of peas in the right kidney. They were, however, indistinct and not compact, showing light spots in the centre.

At operation, no stones were found and the shadows were found to be due to calcified glands. The colicky pains were found to be due to fresh, firm adhesions of the transverse colon and flexure with the hepatic border, the gallbladder, which contained no stones, being also embedded in the adhesions. The adhesions were broken up. Cholecystectomy.

The author has re-examined the patient two and a half years after the first, and one and three-quarter years after the second operation. She was free from complaints and able to eat all kinds of food. A roentgen examination showed a moderately prolapsed atonic stomach with perfectly normal peristalsis and normal evacuation. The duodenum was perfectly normal.

In communicating the symptoms and findings, the author says that the roentgen findings, while not characteristic enough to make a positive diagnosis of congenitally abnormal ligamentous connection, made it possible in conjunction with the clinical diagnosis to clear up this important and interesting symptom complex and its cause. This condition will have to be considered more frequently in future in the differential diagnosis.

The author also communicates a second case which showed roentgenological symptoms of stenosis of the small intestine, and in which an abnormally short hepatoduodenal ligament was found at operation.

BOOK REVIEWS

TRANSACTIONS OF THE TWELFTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR THE STUDY AND PREVENTION OF TUBERCULOSIS. 517 pages. Published by the National Association for the Study and Prevention of Tuberculosis, 105 East 22nd Street, New York.

The National Association for the Study and Prevention of Tuberculosis has issued a stately volume of 517 pages, embodying the transactions of the twelfth annual meeting which was held at Washington on May 11 and 12, 1916. As was to be expected, the roentgenological interests have found an echo in the proceedings in view of the growing recognition of the importance the roentgen ray is destined to assume in the diagnosis of pulmonary tuberculosis at a stage when the ordinary clinical methods are inadequate or doubtful. The two papers presented show the present status of roentgenology in this respect, as viewed from different angles, while the discussion which followed the reading of these papers reflects the attitude of clinicians on the subject.

The first paper, by Dr. Charles L. Minor, of Asheville, was entitled:

"THE USE OF THE X-RAY IN THE DIAGNOSIS AND STUDY OF PULMONARY TUBERCULOSIS"

and the following is an abstract.

Having applied the *x*-ray (screen method) to the study of pulmonary tuberculosis for some eighteen years, Dr. Minor has formed some very definite conclusions as to its value both as a means of early diagnosis and of what he calls "topographic" or "geographic" diagnosis. Between these two he makes a sharp distinction, the former to disclose incipient lesions as such and the latter the extent, progress or retrogression of the pathological process. Although the stethoscope is a simpler instrument than a roentgen outfit, and gives a better idea of the activity and nature of the affection, the roentgen method gives better information of the extent of the process. To accomplish this object, the author has found roentgenoscopy preferable to photography, in accordance with European practice, not only because screen pictures are simpler to interpret but also because there is no break in the observations which would of necessity occur by having to wait for the plates to be developed, studied and interpreted. It follows that the clinician should preferably be his own roentgenologist and he trusts that before long every lung specialist will feel the necessity of having a roentgen equipment in his office. Stereoscopic plates, though useful, are in his opinion not necessary in every case and their routine use would therefore involve unnecessary expense.

In the vast majority of cases, the diagnostic use of the roentgen ray is much less important than its topographic use. The roentgen method is not essential for a satisfactory early diagnosis, although in certain cases it gives first information, while in others it corroborates what otherwise is only a suspicion. On the other hand, *x*-ray findings are often negative in positive physical examinations, and in such cases the latter are decisive.

In incipient cases, for the majority of which he considers the old clinical methods sufficient, the author describes five changes from the normal lung picture: (1) apical shadows; (2) apical shrinkage; (3) hilus shadows and bands connecting these with the apex; (4) limitation of motion of the base, or Williams' sign; and (5) filmy bands of infiltration running outward from the hilus to the outer border of the lung field at the second or third rib, although these latter are not, strictly speaking, incipient changes.

Apical shadows are of two kinds: (*a*) a diffused clouding, due to either apical pleurisy or to a diminution of air content in the apex from the pressure of fine tubercles on the finest air passages, and (*b*) isolated small foci, due to a deposit of conglomerate tubercles. Absence of apical shadows does not nullify the presence of distinct physical signs; the presence of apical shadows without physical signs probably points to old healed foci. The failure of an apex to become clearer on taking a deep breath has not been found by the author to be a sign of value.

Roentgen examination has shown that the tubercular process does not usually begin in the apex where the first physical signs are found, but in the glands around the roots of

the lungs where incipient changes can not be revealed by auscultation and percussion. These, together with other technical findings, detailed by the author, are important but not necessary in the majority of cases. Their chief value is brought out as corroborative evidence in clinically doubtful cases.

As to the "geographic diagnosis," no matter how often one may percuss and auscultate the patient's lungs, the idea one gets of the extent and peculiar shape of the lesions is incomplete, while with a sufficiently large and properly illuminated screen, or perhaps a pair of stereoscopic plates, these matters can be settled with wonderful clarity. In the study of abscesses, cavities, bronchiectasis, pneumothorax, hydro- and pyothorax, and interlobular pleurisies, it is not merely useful but essential to a complete understanding of the case. The author proceeds to consider the interpretation of the shadows: cellular infiltration by cutting off the air supply of the part; old, thick, dry pleurisies; shrunken lungs; caseation; masses of tubercle; fibrosis; calcification; old, enlarged lymphatic glands; adhesions; effusions; marked empyema; deep-seated foci which escape all other manners of examination; interlobular pleurisies which can not otherwise be demonstrated; abscesses, in the study of which roentgenoscopy will clearly reveal small unsuspected pneumothoraces; bronchiectases along the descending bronchus or in isolated places. The shape and nature of the shadows are likewise described, and the author goes on record to state from eighteen years' observation that, contrary to the assertion of other writers, the shadows of fibroid trouble and of more active trouble can be distinguished beyond peradventure of a doubt: dark, sharply defined shadows go with healed or healing processes; cloudy masses floating over the lung picture, like a sea fog blowing over the land, are uniformly connected with advancing and active trouble. Holzknecht has expressed the same view.

As to cavities which were formerly only revealed at autopsies and which physical diagnosis can not demonstrate, are revealed by the roentgen ray. The cavity with a marked fibroid wall is very easy to recognize as a bright cellular or oval area, surrounded by a dark wall of scar, especially when there is fluid in it with a demonstrable motion. In the study of artificial pneumothorax, the author holds that no one is justified in carrying out this procedure without the assistance of the roentgen ray. He concludes his valuable contribution with the following words [which the Editor believes debatable]:

"Only when the clinician shall *himself* use the *x*-ray in his every day office work *and on every case*, will he get that mastery of it which is essential, if it is to guide and not to mislead him; and if he is to derive from it the assistance it is capable of giving and only when the clinician so masters it, instead of trusting to another man's report of what this other man has seen, will we finally be able to settle many of the yet unsettled points which await solution."

The second paper was read by Dr. Frederick H. Baetjer, of Baltimore, under the following caption:

"The Early Diagnosis of Pulmonary Tuberculosis by X-Rays: The Roentgenological Aspect."

The value of Dr. Baetjer's contribution to the roentgen diagnosis of incipient tuberculosis would seem to lie in its negative character, much in the same way as the report of clinical and surgical failures in any pathological condition is as valuable for practical purposes as the report of unqualified successes. In other words, he rather tells us what the roentgen ray can not do in the affection under discussion than what it can do and does.

To begin with, he calls attention to the fact that the identical roentgenogram may show normal conditions in the lungs of a man of 70, and pathological conditions in those of a young man of 20, the reason being that the shadows which constitute the roentgenogram are produced by a certain amount of density which is normal in the old and pathological in the young. This is one of the items where the personal history of the patient will seriously affect the diagnosis based on the interpretation of a roentgenogram. This, however, has nothing to do with tuberculous changes. The question rather is: Can we recognize slight changes early and pronounce them absolutely as tuberculous? The author holds we can not. The roentgen method can detect very early permanent changes much earlier than the clinician, but it is unable to determine the etiological factor. So, while at a very early stage roent-

genological changes may be seen, they show nothing pathognomonic of tuberculosis and are therefore insufficient to base an etiological diagnosis upon. On the other hand, at a time of pathological development when such is possible, the clinical diagnosis no longer requires the aid of the roentgen ray.

His next point deals with autopsy findings which show that some trace of tuberculosis is found in all lungs. Consequently, slight roentgenological changes do not necessarily indicate an active process but may be the result of an old infection. So, there is a difference between roentgenological and clinical tuberculosis.

As to the question whether tuberculosis is primary in the lungs or in the lymphatic tissue or in the mediastinum, the author holds that it is so most commonly in the lungs, that the primary lesion may be healed and yet the mediastinal lesion be active and involve the lung again by direct extension. Consequently, in this type a fairly positive diagnosis may be made because, with the exception of malignancy, this is the only lesion that can be considered. The greater deposit of calcium in the peribronchial glands in these cases is an additional aid in children, but does not hold good in adults where many other causes may produce calcification.

Roentgenological signs which help in an early etiological diagnosis are small patches of apparent consolidation scattered throughout the lung substances and a slight clouding of the apex giving the appearance as if the pleura had become a little thickened and at the first rib on that side flattened out, due to the contraction of the lung, so that the apex on the affected side is smaller than on the other. These signs are apt to be of tuberculous origin, but not always, as certain types of influenzal infection may give the same picture.

Furthermore, many simple chronic affections may furnish the same roentgen picture as the early stages of tuberculosis, and it is only the further development of the case that will clinch the roentgenological diagnosis as positive. The clinical condition would therefore always have to be taken into consideration in conjunction with the roentgen findings.

In the discussion following the reading of these papers, *Dr. Lawrason Brown*, of Saranac Lake, told the meeting his impressions derived from his clinical experience. The experience they had at Saranac Lake some fifteen years ago with the roentgen method was so unsatisfactory that they let it drop, and when at a later period they were able to observe the movement of the diaphragm, they found that this gave no better information than careful percussion. The first experience was garnered with an old static machine, and the second with a Tesla coil, using the alternating current, as that happened to be in use at Saranac Lake.

The next experience transpired some eight or nine years ago, when in a case of hemoptysis the examining physician could find no signs. Then an *x*-ray man came upon the scene in the person of Dr. Cole, who decided that there was something in the third and fourth interspaces to the left of the sternum and, curiously enough, physical signs developed just where the *x*-ray man said he had seen the lesions. That dispelled his skepticism and he is now rapidly being won over.

In the meantime, Dr. Brown had made careful studies of the roentgen process and its results from a clinical point of view. He found roentgenoscopy excellent for gross lesions which are often shown to extend much further than physical signs would indicate. Besides, the fluoroscope is very valuable in checking up the physical examination. Flat plates he has found very difficult to interpret, the superimposed shadows being liable to clash. To have these shadows cleared up, stereoscopic plates are necessary, and these should therefore always be used for very fine and early diagnosis. With the aid of stereoscopy a definite diagnosis can be made long before the fluoroscope discloses lesions or physical conditions present definite symptoms. The same remarks apply to the detection of cavities, and Dr. Brown cites instances to that effect from his own practice. Bearing in mind the danger of inaccurate diagnoses from poor plates interpreted by poor observers, Dr. Brown believes tuberculosis should not be excluded in any patient until a stereoscopic plate has been made and a total absence of gross lesions in the lungs has been established.

Dr. A. M. Forster, of Colorado Springs, deprecated the enthusiastic attitude of the roentgenologist as to the importance of his early diagnosis. As in his experience was already the case, this led the general practitioner to believe that the roentgen evidence

was absolutely dependable and final, and would go far toward delaying the results of the patient work of the last ten years; but he had no fault to find with the attitude taken by the speakers on the present occasion.

Dr. Frederick H. Heise, of Saranac Lake, agreed that a roentgen diagnosis of pathological conditions in the chest, in conjunction with the physical signs, is of a great deal more value than the latter alone. As to the roentgenoscopic and roentgenographic procedures, each had its own value. The fluoroscope did not always agree with the findings on the plate, because too great a penetration was used in the latter. By gradually increasing and decreasing the penetration in fluoroscopic work, the screen picture would vary, and with greater reduction in the penetration the variations against the plate results would increase.

He would distinguish between the peribronchial and parenchymatous types of chest involvement, although there was no pathological evidence of the *x*-ray shadows really representing the pathology in the lung. Classifying the lesions into incipient and moderately advanced purely on physical signs, and then upon roentgen evidence into the peribronchial and parenchymatous types, a difference would be found between incipient and moderately advanced cases in these two groups. The difference was readily seen when comparing the frequency of râles, tubercle bacilli in sputum and such symptoms as hemoptysis, pleurisy and fever.

They had found in an analysis of three hundred cases that of the peribronchial type only three per cent. had tubercle bacilli in their sputum at the time the plates were taken as against forty-six per cent. in the parenchymatous group. Râles were present in thirty-three per cent. of the peribronchial type and in seventy-five per cent. of the parenchymatous type. Comparing in like manner previous hemoptysis, the results were twenty-seven per cent. in the peribronchial and forty-eight per cent. in the parenchymatous type. Pleurisy and fever had about the same percentage of occurrence. This showed the justification of the classification into two distinct types, and if the *x*-ray had done nothing more than dividing the cases into these classes it had served its purpose well, although there was no positive proof that such groups exist.

Furthermore, comparing the incipient cases of the two groups, a much smaller percentage of positive sputum was found in the peribronchial group, but the percentage of relapses in the course of years in the peribronchial group would approximate only one-half of those in the other. This ratio also applied to the moderately advanced cases.

Dr. H. K. Dunham, of Cincinnati, had not heard so many nice things said about the roentgen ray in his whole life as at this meeting. What he appreciated about the roentgen ray is that we do not have a doctor, we do not have brains, we do not have any judgment at all, but we do have an instrument of precision for recording differences of density and shape which are evidence of tuberculosis.